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The Reconstruction of the Bridge over the River Gère: The Engineering Work of Michael Servetus

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Abstract

Michael Servetus, renowned for his medical and theological contributions, is less known for his involvement in civil engineering. This article delves into Servetus's role in the reconstruction of the Pont de Gère in Vienne, France, after its catastrophic collapse during a flood in October 1544. Based on historical testimonies and archival evidence, the study examines Servetus's technical contributions in two key aspects: the decision to adopt a two-arch design to enhance structural stability and his innovative recommendations for foundation construction to mitigate hydraulic challenges. These interventions, informed by Renaissance engineering principles and ancient Roman construction techniques, proved crucial to the bridge's durability, which stood for over four centuries. This article highlights Servetus's multidisciplinary ingenuity and underscores his significant, yet often overlooked, contributions to engineering history.

Keywords: *Michael Servetus; Bridge; Vienne; Arches; Foundations.*

Introduction

Miguel Servet (Fig. 1), in 1541, arrived in Vienne, Isère (also known as the "Vienna of the Dauphiné"). Assuming that he was born on September 29, 1511, in Villanueva de Sijena (Huesca), when Servetus settled in Vienne, he would have been approximately thirty years of age. By that time, he had been subjected to Inquisition-related persecution for approximately ten years, accused of heresy following the publication of his De Trinitatis Erroribus, and separated from his family, home, and country for approximately half of his life.

Doctor, mathematician, theologian, writer, and astronomer. From an early age, Servetus engaged in the study of Latin, Hebrew, and Greek, demonstrating remarkable proficiency and dexterity in all three languages.

At the age of fifteen, he commenced his tenure with Fray Juan de Quintana, a cleric who would later become the confessor to King Charles I. With Quintana, he undertook a journey through Granada, Valladolid, and Toledo, and was present at the imperial coronation of Charles V in Bologna in 1530. Subsequently, Servetus separated from Quintana and became involved with reformist circles, thereby commencing a journey through Central Europe that would ultimately lead him to reside in Basel, Strasbourg, Toulouse, and finally Paris. During this period, he taught mathematics, geography, astronomy, and astrology, and also met Calvino (Sanz Agüero, 1973).

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Fig. 1. Michael Servetus in an engraving by Cristoffet van Sichem: considered the most reliable image of the Aragonese thinker, despite having been made 54 years after his death (Morón Bueno, 2008, 49 – 50), preserved in the National Library.

Facing economic challenges in Paris, he relocated to Lyon, where he was employed at a printing press and published an edition of Ptolemy's Geography, a work that showcased his profound erudition (ARRIBAS SALABERRI, 1976). At this juncture, he resolved to pursue a medical degree. This decision resulted in his return to Paris, where he spent several months engaged in the dissection of corpses. He subsequently resumed his studies in mathematics and astrology at the Collège des Lombards. Nevertheless, his forays into the domain of judicial astrology ultimately resulted in a confrontation with the University, which could have culminated in his execution. Subsequently, Servetus opted to depart Paris and seek asylum, initially in Charlieu and subsequently in Lyon. During this period, he engaged in the practice of medicine and undertook the preparation of multiple publications in both locations.

While in Lyon, Servetus encountered Pierre Palmier, who had been Archbishop of Vienne since 1528, primate of Gaul, and with whom he had been acquainted during his tenure in Paris. Palmier was a simple, curious, and erudite man, with a great devotion to the arts and sciences, who aspired to transform the Viennese archbishop's palace into a prominent cultural hub (Cavard, 1953). Attracting Servetus to Vienne was a strategic decision that could potentially contribute to the realization of this vision. Palmier consequently offered Servetus the position of personal physician in the city of the Dauphiné.

This is how Michael Servetus came to reside in Vienne in 1541. Servetus remained in the French city for the following twelve years, under the protection of Archbishop Palmier, who employed him as his official

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physician (Drummond, 1848). For many scholars, these will be the quietest (Martínez Laínz, 1976, p. 86) and happiest years of their lives (Barón Fernández, 1971, p. 135), although there are some experts who question this supposed happiness (Cremades Sanz-Pastor, 2008, pp. 95–96).

Both positions are supported. In contrast to the vicissitudes of previous years, Servetus enjoyed considerable prestige as a doctor, boasting a highly select clientele, which brought him a substantial income (González Echevarría, 2011, 206). His medical work enabled him to pursue his studies and publications, and he was able to rely on the protection of the Archbishop. Consequently, during his tenure in Vienne, Servetus was able to pursue the practice of medicine while simultaneously producing several publications, including Declarations Jesu Christi filii Dei libri V (which was not attributed to him until many years later), the Bible of Santes Pagnini (1542), the *Biblia Sacra Glossis*, five editions of Syruporum, and finally his most renowned and seminal work, the *Christianismi Restitutio* (1553).

However, to refute the argument of those who consider that Servetus enjoyed his happiest time in Vienne, it is important to note that Michael Servetus was a Spaniard (Aragonese) who had sought refuge in France as a result of the persecution he faced for publishing his works, which were deemed heretical, and that he was prosecuted in absentia by the Courts of Toulouse and claimed by the Spanish Inquisition (Fuentes Sagaz, 1999). In fact, Servetus resided in Vienne under the name of Miguel de Villanueva or Michel de Villeneuve, a name he had adopted before he arrived in Lyon. This was done to evade the institutions that were persecuting him, and he stayed in various houses belonging to prominent individuals.

Servetus's forced exile, a consequence of the persecution he faced at the hands of the Spanish Inquisition, which even prompted his brother to seek his return to Spain for trial, and the French laws, which, among other restrictions, prohibited foreigners from holding office, obtaining benefits, or disposing of their assets in a will, led him to apply for French citizenship. This application was granted on July 5, 1548 (González Echevarría, 2011, 222–230). Consequently, he became a subject of King Henry II, enjoying the same rights and obligations as any Frenchman by birth. In this way, he was able to integrate himself into municipal life and, most importantly, he was able to reinforce his false identity (Michel de Villeneuve) in order to go unnoticed.

With French nationality already recognized as a citizen of Vienne and destined to await death there after so many vicissitudes, Michel de Villeneuve participated in certain municipal affairs, although these were not issues that aroused great interest in him (Arribas Salaberri, 1974). Accordingly, his presence at the consular house on three occasions and at other locations on four occasions is substantiated by documentation (Cavard, 1953).

In the two years following his French naturalization, he was appointed prior of the confraternity of San Lucas for pharmacy and medical care and elected prior physician of Vienne (Arribas Salaberri, 1974). He held this position for two years, from October 18, 1550, to October 18, 1552 (Fuentes Sagaz, 1999, 70). In addition to assuming responsibility for providing free hospital care for indigent patients, he became a member of the city's Municipal Council.

It is within this context that the circumstances that give rise to this article come into focus. In October 1544, a catastrophic flood destroyed the bridge over the Gère River, a tributary of the Rhône. In light of the project's significance, the authorities convened the town's nobility to ascertain their perspectives on the reconstruction, including that of Michael Servetus, who would play an active role in this undertaking.

The intervention in this reconstruction enabled Miguel Servetus to showcase a hitherto unknown facet of his abilities, which were not required in the capacity of an engineer, but rather as a mathematician (Arribas Salaberri, 1974) or a doctor (Cavard, 1953). He had become a respected and prominent figure in his adopted city.

From another perspective, the significance of a bridge is worthy of consideration. Michael Servetus was born in the Renaissance, a period of significant transition from medieval scholastic traditions to a new era of intellectual exploration. During this time, there was a growing emphasis on the value of human nature,

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with a renewed interest in the Greco-Latin classics as a source of wisdom and inspiration. The bridges of this period are a reflection of Renaissance engineering, which was significantly influenced by Roman tradition and technique (Sáenz Ridruejo, 2008, pp. 349–352). The Renaissance marked a fundamental shift in how life and the world were conceived, with significant implications for the practical applications of science, particularly engineering. The design and construction of bridges, in this regard, exemplifies this transition (Fernández-Ordóñez Hernández, 2008).

Additionally, in Vienne, in 1546, Servetus would resume his epistolary relationship with the reformer Calvin, which would ultimately be used as evidence against him and result in his condemnation (Servetus, 1971). Concurrently, he would compose and publish his magnum opus, Christianismi Restitutio. This was a highly detailed theological work in which, somewhat unusually, the pulmonary circulation of the blood was analyzed. This was the discovery for which Michael Servetus is best known and which led to his condemnation to death. Christianismi Restitutio was promptly identified as heretical and ultimately resulted in Servetus's arrest on charges of heresy, which was subsequently tried in the city of Isère that had previously extended him a warm welcome.

On the night of April 7, 1553, Servetus escaped from prison and fled from Vienne. Nevertheless, the proceedings against him persisted. On June 17, 1553, he was sentenced to be burned at the stake in effigy along with copies of his works. The sentence was carried out on the same day (Cavard, 1953).

After a period of more than four months spent in locations that are now unknown and about which there has been much speculation (Fuentes Sagaz, 1999, 81), Servetus was identified in Geneva at the beginning of August 1553. He was imprisoned at the request of John Calvin and subjected to a rather tendentious trial, resulting in a sentence of death by burning.

Objectives

The principal aim of this article is to examine the role of Michael Servetus in the design and subsequent construction of the Gère Bridge, which had previously been destroyed by a flood.

The following are specific objectives:

- The objective of this investigation is to examine the circumstances that led to the collapse of the previous bridge and to analyze the factors that influenced the decision to construct a new one.

- The objective of this investigation is to examine the decisions made and communicated by Michael Servetus regarding the construction of the new bridge. This examination will be contextualized within the historical context of the project's inception and the subsequent stages of its development.

- The objective of this study is to evaluate, from a technical standpoint, the merit of Michael Servetus' contributions.

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Fig. 2. General view of the Bridge over the River Gère subject of this article, photographed upstream on an old postcard, from the early twentieth century (VVAA, 2020).

Background and Situation

Vienna is a city of French origin, established before the Roman era, situated within the department of Isère, in the Auvergne-Rhône-Alpes region. It is located on the banks of the Rhône River, at the point where the Gère River flows into it.

The bridge that motivates this research made it possible to cross the River Gère very close to its mouth (Fig. 3, Fig. 8 and Fig. 9). For this reason, it was known as the Pont de Gère, although for historical reasons it was also known as the Pont de Saint-Sévère (Brissaud, 2018, 70; Cavard, 1953, 31) in line with the name of the church to which it led (Savigné, 1877, 76; Fig. 4) and also as the Pont Saint-Louis, as it connected the square of the same name (Fig. 4). Indeed, the bridge was initially named the Pont de Saint-Sévère, later becoming known as the Pont de Gère, which would ultimately become its definitive appellation.

The bridge spanned the Rue des Quatre-Vents (north abutment) and the Rue de l'Eperon (south abutment). For an extended period, and until the construction of other bridges, it served as the primary route for transportation along the Lyon-Provence road. The bridge was ultimately destroyed in 1967 as a result of the river Gère being buried (Fig. 3) at its mouth in the Rhône (Brissaud, 2018). That is why the Bridge cannot be contemplated at present nor can any recent photograph of it be contributed to this article: all the illustrative prints collected here are old images (Fig. 2, Fig. 5, Fig. 7, Fig. 8, and Fig. 9).

The Bridge has a lengthy history, extending back to the depths of the Middle Ages or potentially even to a more primordial era (Chorier, 1828, 59–64). Throughout its existence, the bridge has been subjected to several landslides, the majority of which have been attributed to the sudden flooding of the river. For example, evidence exists indicating that a flood occurred in 1280, resulting in the partial destruction of the bridge (Chorier, 1828, 59 – 64; Savigné, 1877, 76 – 78).

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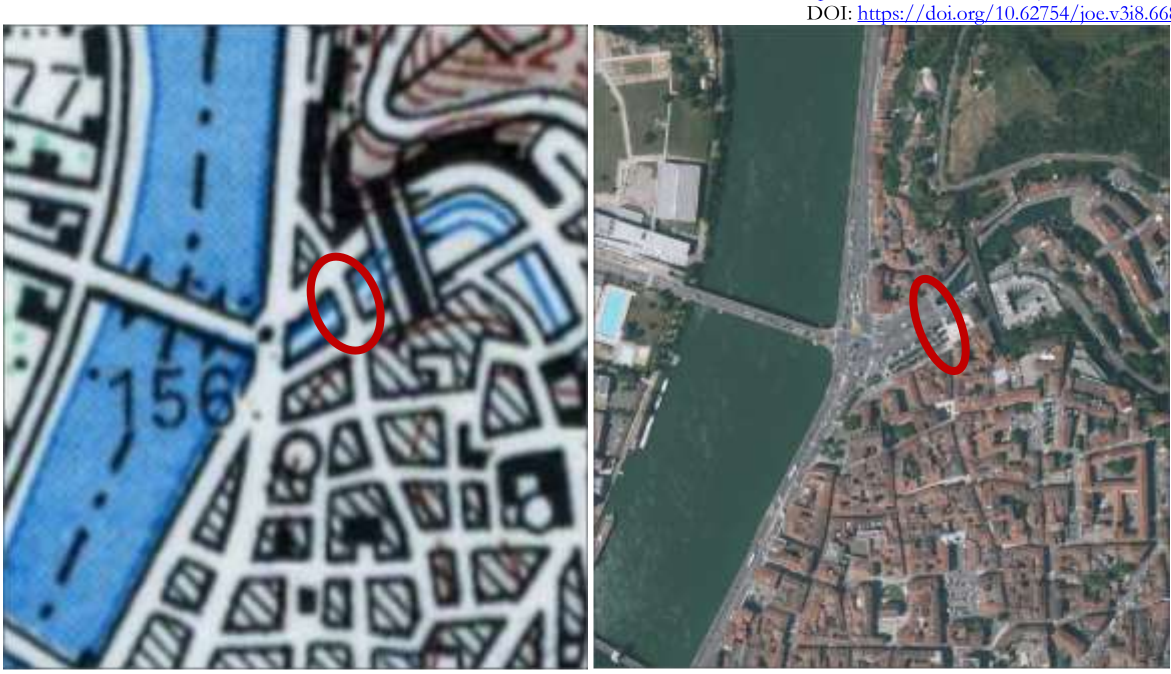

Fig. 3. Location of the Gère Bridge on the cartographic map of 1950 (left), when the Bridge still existed, and the place that the bridge would occupy on current aerial photography (right): montages made by the author on images obtained from the French National Geoportal (Géoportail).

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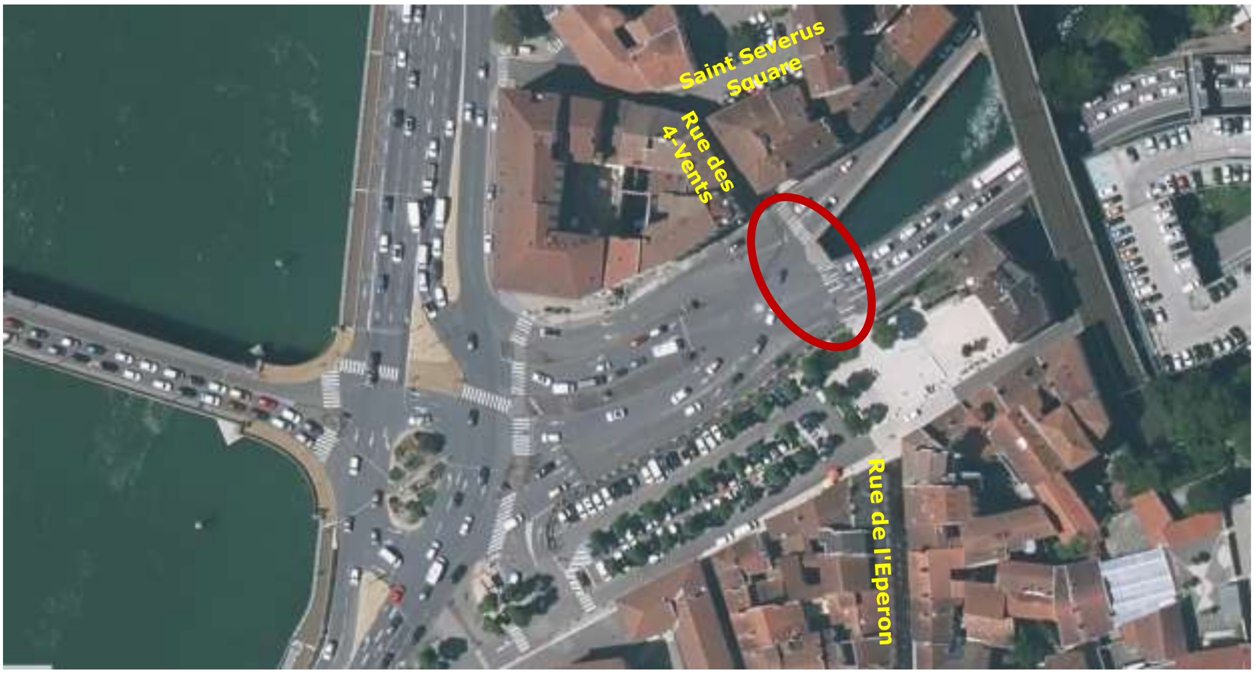

Fig. 4. Place that would be occupied by the bridge over current aerial photography (right): montage made by the author on an image obtained from the French national Geoportal (Géoportail).

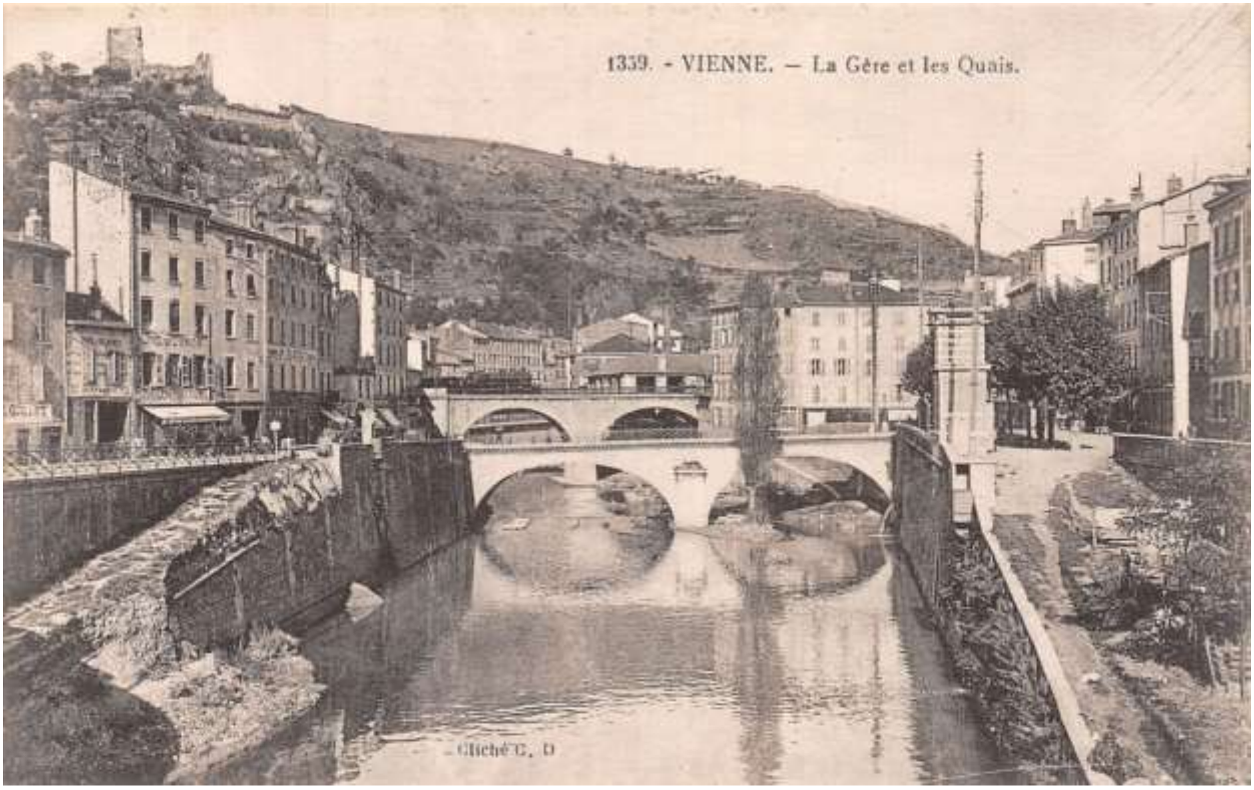

Fig. 5. General view of the River Gère, with the bridge that is the subject of this article, photographed downstream, from the mouth of the Gère in the Rhône, on a postcard from the early twentieth century (VVAA, 2020).

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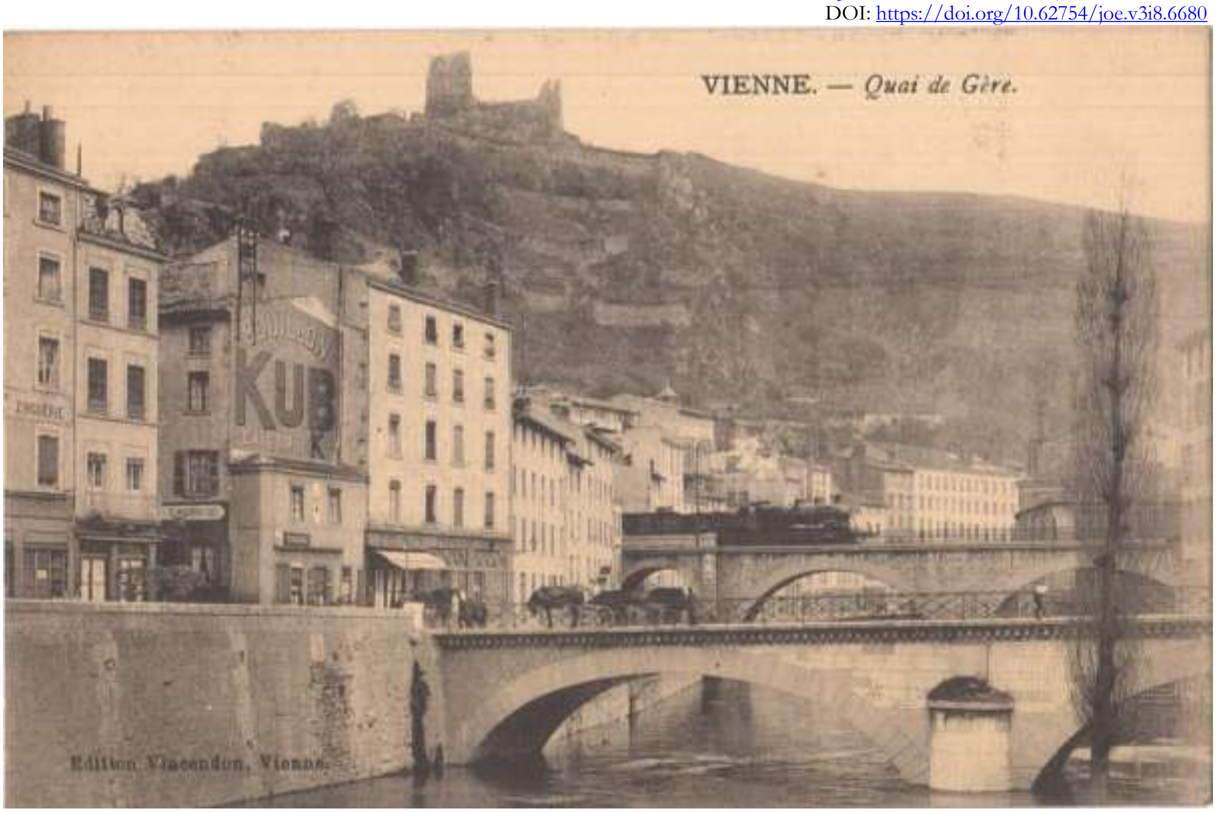

Fig. 6. Partial view of the elevation of the Pont Gère, showing the north abutment and the arch that rests on it (Rue des Quatre – Vents side) and the start of the other arch in the pier, photographed downstream at a time when there was an increase in the rise in the water level (compare with Fig. 2 or Fig. 5), on a postcard from the early twentieth century (Brisaud, 2018, 136).

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Fig. 7. General view of the deck of the Bridge over the River Gére subject of this article, photographed from the Rue des Quatre – Vents, in a postcard from the beginning of the twentieth century (VVAA, 2013).

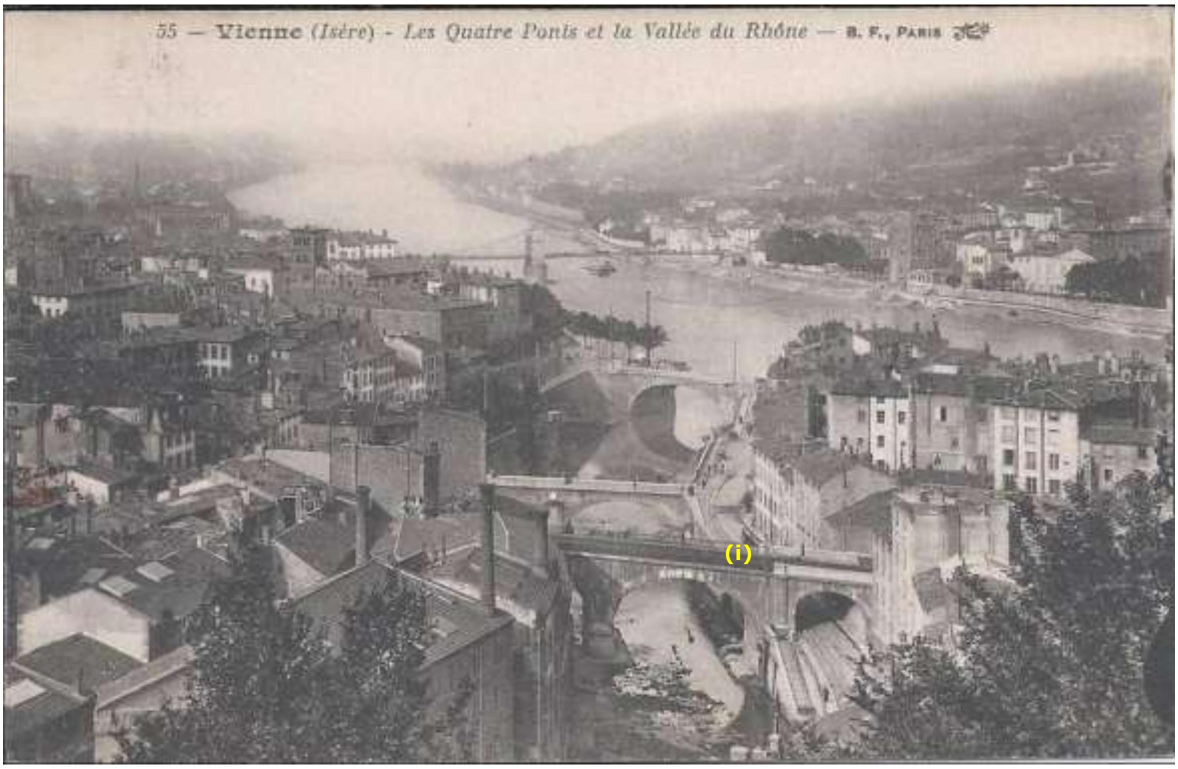

Fig. 8. General view of the city of Vienna and the mouth of the Gére on the Rhône in an old image, showing the location of the Gére Bridge (i), on a postcard from the early twentieth century (VVAA, 2013).

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Fig. 9. Partial view of the city of Vienna and the mouth of the Gère on the Rhône in an old image, showing the location of the Bridge (i), on a postcard from the early twentieth century (VVAA, 2020).

However, it seems that no flood reached the magnitude of the flood produced on the night of October 12 to 13, 1544. At seven o'clock in the morning, this flood destroyed the bridge, demolished with it almost all the houses built on the banks of the river, and claimed the lives of nineteen people, whose bodies were recovered from the rubble generated by the collapse (Chorier, 1828, 59–64; Savigné, 1877, 76–78). The damage caused was of such magnitude that it affected navigation on the Rhône. The enormous quantity of debris generated was transported downstream to the mouth of the Gére, where it was deposited on the right bank of the Rhône. This rendered navigation on that flank of the river impossible.

The collapse of the bridge had far-reaching consequences, affecting not only human and road safety but also communication and the economy. The route, which was a major thoroughfare connecting Marseille and Lyon, was rendered impassable, resulting in the disruption of trade. From an economic standpoint, the situation was dire. Many residents were compelled to relocate from Vienna due to the lack of trade, communication, and prospects for the future (Savigné, 1877, 76–78). Immediate action was required to prevent the collapsing bridge from dragging the city into ruinous collapse. Consequently, on the day of the collapse, the consuls convened to assess the situation and determine how to address the resulting disaster. To address this issue, a provisional navigation service was established to facilitate pedestrian crossings over the Gère.

One year later, a provisional wooden bridge was constructed, while a more enduring solution was meticulously planned and implemented, ultimately leading to the construction of the bridge itself. The consuls exerted their utmost efforts to expedite the reconstruction of the factory, even anticipating substantial economic assistance from King Henry II, who assumed a considerable portion of the financial burden due to the prevailing scarcity of resources.

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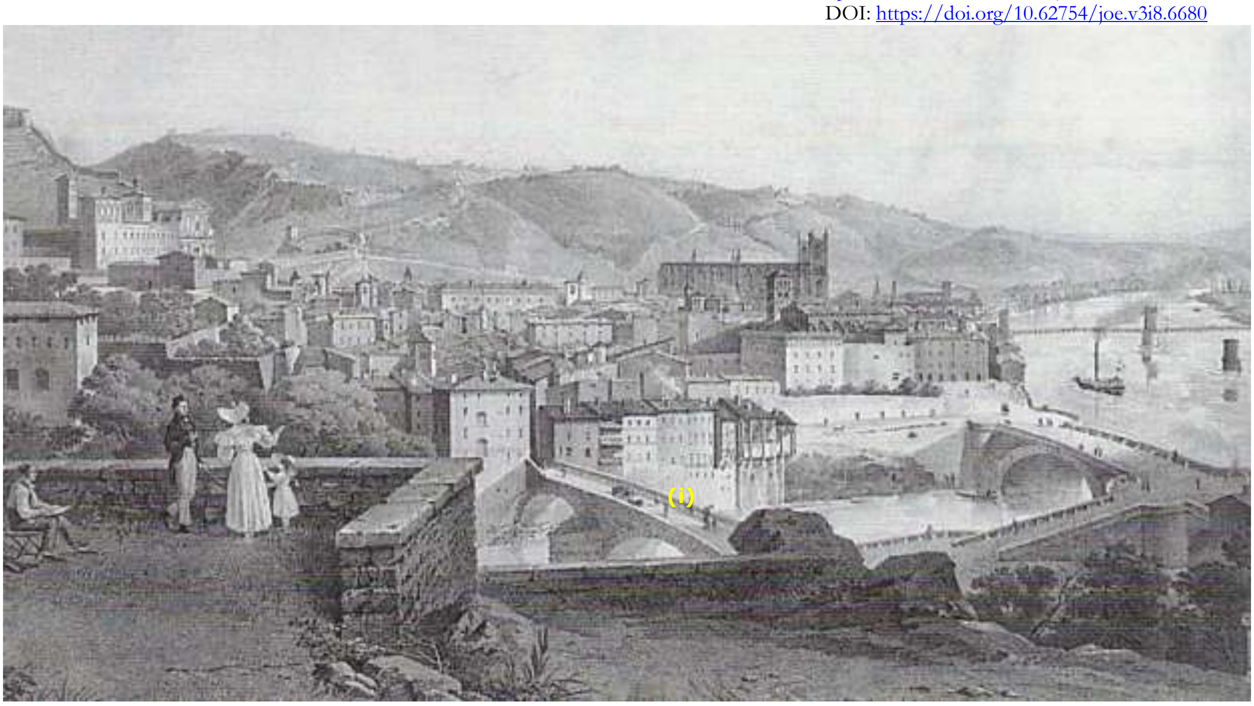

Fig. 10. Vienne in 1831, engraving by Étienne Rey, where the location of the Pont Gère has been marked in the only image that has been accessed before the mid-nineteenth-century action (Brisaud, 2018, 136).

The resulting bridge would be composed of two arches and an intermediate support. The bridge remained in its original state until the mid-nineteenth century when Savigny provided the following description:

> *" Il était étroit, avec des parapets en maçonnerie couverts de dalles et servant d'appui; la circulation en était difficile, et un espace plus large existait au milieu, sur la pile; le sol avait des pavé pointus, comme d'ailleurs dans toute la ville. Le pont faisait ce qu'on appelle vulgairement un dos d'âne. Après la démolition des masures du quai Ecorcheboeuf et de la maison Colombat, qui occupait l'emplacement actuel de la place SaintLouis, des réparations importantes furent faites au pont de Gère; il fut nivelé, aplani, et l'on y ajouta, en dehors, des trottoirs et des balustrades en fer* [sic]*"* (Savigné, 1877, 76).

In consideration of the aforementioned limitations (narrowness, difficulty of transit, and pointed cobblestones), the demolition of certain nearby buildings was employed to facilitate repairs to the bridge in the mid-nineteenth century. Consequently, the majority of the photographs presented in this document do not align with the image of the bridge that was rebuilt in the sixteenth century. It should be noted that the image presented here does not include the masonry parapets covered with slabs that served as support, as Savigny observed. Instead, it depicts a platform with perimeter sidewalks and wrought iron balusters (Fig. 2 and Fig. 7). Prior to the aforementioned action, only one image was obtained: an engraving by Étienne Rey, which shows a general view of the city in 1831 and in which the bridge can be distinguished (Fig. 10).

The final iteration of the bridge would feature a gate on its southern abutment (that is, the side facing Rue de l'Eperon), which would serve to control access to the city. For a considerable period, the city did not expand south of the bridge (Chorier, 1828, 59–64).

The Gère Bridge thus exemplifies the repair and subsequent reuse of a medieval bridge during the Renaissance, when bridges reclaimed their role as a conduit for communication and transportation (Sáenz Ridruejo, 2008, 349–352). This contrasts with the earlier divisionist and warrior-centric conceptions of medieval bridges. Moreover, some scholars have postulated that the bridge may have Roman origins, which would further enhance its significance during the Renaissance period (Chorier, 1828, 59–64). In conclusion, the bridge was a Renaissance structure that was influenced by the input of a scientist and humanist from the same era.

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Fronts of Participation

Although the bridge was already in existence, the collapse necessitated a reconstruction approach that considered the work to be carried out as a new structure. This resulted in the emergence of distinctive characteristics, typical of the era and the mentality in which it was built (Sáenz Ridruejo, 2008, 349–352).

Michael Servetus was involved in the design and initial construction of the bridge in two distinct capacities:

- the first of them, during the projection of the Bridge, to determine whether the construction should be executed with a single arch or with two and, therefore, with an intermediate support pier; and
- the second, already in the execution phase, to decide on the best solution to guarantee an adequate foundation and support for the construction that was undertaken.

In the following sections, each of the fronts of action is analyzed in detail.

Number of arches

As previously demonstrated, a substantial flood of the River Gère resulted in the destruction of the Pont de Saint-Sévère on the morning of October 13, 1544. In the following year, a wooden footbridge was constructed as a provisional measure to replace the collapsed bridge, which constituted the principal route for travel from Lyon to Provence via Vienne. In light of the vital role this transportation route played, it was imperative to construct a more resilient and durable bridge. Even the monarch himself contributed to this endeavor.

At this juncture, the process of development of the new bridge commenced. As evidenced by various written testimonies, including that of Pierre Cavard, on February 15, 1548, Dr. Miguel de Villanueva, a prominent local figure, was summoned by the consuls, along with other distinguished residents, to the House of Sainte-Barbe to provide counsel and make decisions regarding the construction of the new stone bridge (Cavard, 1953, 31). It is noteworthy that a period of three and a half years had elapsed since the collapse of the previous bridge due to flooding.

From the perspective of the present, the meeting at which Servetus was summoned may appear to lack rationale. However, during the Middle Ages, it was customary for master builders to convene during the design phase of a bridge project to address various technical matters. These included geometry, the selection of an appropriate foundation type based on the terrain, the construction procedure, and, although this was not applicable in this case, the specific location for the implementation of the structure.

It is also noteworthy that Servetus was not yet a French citizen; he would not become so until that summer. The laws did not require French nationality for participation in the deliberations for which he had been summoned (Cremades Sanz-Pastor, 2008, 96).

Once the project for the new bridge was presented, the primary issue to be addressed was the number of arches that the future bridge should incorporate. To inform this decision, a report prepared by the experts was presented for consideration:

> " *Sera, disent-ils, le plus comode, propice et de plus grande asseurance, de fère deux arcs aud. pont, l'ung de soixante piedz de largeur à la part de l'églize Sainet Sevez, et l'aultre à la partie de la ville, de la largeur que sera nécessaire et plus petit. Et de fayre une bonne et puyssante pille au myllieu, de pierre de choings, bien et profondément fondée sur paulx... Et, n'y feroyt qu'un arc, il seroyt tropt grand et long, actendu la distance du lieu; et ne scauroyt ne pourroyt estre si fort ne puyssant. Aussi seroyt tropt hault et mal aysé à monter et descendre par charrectes* [sic]" (Cavard, 1953, 31).

The question thus arose as to whether the bridge should be constructed with one arch or two arches. The experts expressed a preference for the latter option, despite the necessity for intermediate support. It is noteworthy that the possibility of an initial asymmetry in the bridge was considered from the outset. This

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was due to the recognition that one of the arches (the one commencing from the north abutment) would span sixty feet (18.30 m), while the second arch would be smaller and of the requisite length to span the channel. The notion of asymmetry lacks substantial engineering support and is not a hallmark of the Renaissance period.

At the aforementioned meeting, held on February 15, 1548, several citizens expressed their opposition to the position conveyed by the experts. They subsequently advocated for the construction of a single bow, rather than the proposed two-arch design. The argument was based on the premise that the river's demonstrated strength could result in a new flood causing the intermediate support of a two-arch bridge to collapse.

Ultimately, the majority of attendees, including Michael Servetus (Cavard, 1953, 31), endorsed the report and the experts' proposal, leading to the decision that the bridge would have two arches.

Was the decision to construct the bridge with two arches an appropriate one in comparison to the monarch solution? Those who had considered the recent collapse of the existing bridge were correct in their assumption that a similar tragedy could occur again.

It was reasoned that the optimal solution would be to construct a single arch of considerable dimensions and considerable height, with the objective of safeguarding it against the potential for torrential floods. This led to the first issue: the optimal height for arch protection would result in a less convenient crossing for pedestrians due to the increased distance from the horizontal. This indicated the necessity for a detailed examination of the two-arch option.

The Gère Bridge commenced reconstruction in the mid-sixteenth century, a period during which structural engineering was not yet a formal discipline (Mas – Guindal Lafarga, 2011). This was before the advent of professional engineers (Mesqui, 1986). As previously stated in the Introduction, we are situated within the context of the Renaissance era, a period marked by significant advancements in engineering construction. It is evident that akin to architecture, engineering was not immune to the prevailing social and cultural sensitivities of the era. Civil engineering, in particular, turned its gaze towards the Greco-Roman tradition, with a particular focus on the Roman utilization of the arch and vault in their civil and architectural constructions.

Viollet-Le-Duc indicates that the fundamental principle of Roman construction is based on the establishment of supports that are capable of offering, due to their settlement and perfect cohesion, masses that are sufficiently solid and homogeneous to resist the weight and thrust of the vaults (Viollet-Le-Duc, 1995, 2). The robustness of the intermediate support pier observed in the photographs of the Pont Gère, to which we have had access, is consistent with this approach (Fig. 2, Fig. 5, Fig. 6, and particularly Fig. 10). In essence, the objective was to disperse the forces, in the form of weights and thrusts, onto fixed buttresses whose inherent resistance, conferred through the inert dead weight, was more than sufficient to maintain the overall stability. In other words, in the absence of elasticity, a consistency was sought that would allow maintenance, respect, and assumption of a fundamental law—namely, the law of gravity—and the perfect cohesion of the whole (Choisy, 1999). Ultimately, the arch represents the ideal embodiment of the ancient pursuit of sustained compression (García Barrón, 2000, 137–150), which enables a significant quantitative advancement in illumination across a span.

The Ten Books of Architecture by Marcus Vitruvius Pollio is the sole surviving treatise on architecture from the Greco-Roman era (Vitruvius Pollio, 1995; Vitrubio Polión, n.d.). It is uncertain whether Servetus was aware of Vitruvius's work. It is evident that Servetus possessed an exceptional understanding of mathematics, exceeding the typical scope of knowledge for a physician and translator of his era (Arribas Salaberri, 1976, p. 9). Given his status as a Renaissance scholar and the enduring influence of the Greco-Latin tradition, it seems plausible that Servetus was acquainted with Vitruvius's work. In addition to its contributions to the field of architecture, Vitruvius's treatise encompassed a range of subjects that aligned with Servetus's scholarly interests, including mathematics, astronomy, and astrology. This suggests that Servetus may have had access to Vitruvius's writings.

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In general terms, Vitruvius recommended compliance with three basic requirements for any construction: solidity, utility, and beauty (firmitas, utilitas et venustas). These principles are equally applicable to bridges. It is evident that the lack of solidity was the primary cause of the previous bridge's destruction. Therefore, solidity was a critical consideration in the design of the new bridge, particularly with regard to the intermediate support required by the two-arched structure. This support system was of particular importance, as it would bear the brunt of the water's forces. A two-vault solution was selected, with both arches resting on an intermediate pier. This pier was designed to transmit the permanent loads of the bridge (or dead loads) to the ground, as well as accommodate the occasional overloads that are typical for a structure of this type.

As previously indicated, the initial asymmetrical approach to the bridge, proposed on February 15, 1548, was notable from an engineering perspective. This was due to the fact that when the vaults adjacent to a pier are identical, the intermediate pier receives balanced thrusts whose horizontal components counteract each other. This provides a guarantee of stability and allows the thickness of the battery to be reduced, as the resulting force that must be absorbed is practically vertical.

Moreover, the concepts of symmetry and centrality were of paramount importance from an aesthetic standpoint during the Renaissance period. The concepts of engineering and the Renaissance must be considered together when examining these issues, as the Renaissance saw the development of theories on the most appropriate methods for solving problems related to structures, in general, and bridges, in particular (Fernández – Ordóñez Hernández, 2008).

This has implications for the comprehension of the flows associated with these structures, which are notably distinctive in their structural characteristics, as well as for the utilization of shoring employed for the formation and provisional support of the arches and vaults. In order to guarantee comprehensive and enduring stability, the vaults of this particular type of bridge were typically constructed simultaneously and bilaterally in relation to the pier.

However, the photographic documentation collected here depicts a symmetrical (or practically symmetrical) bridge of two arches with an intermediate support, which is constituted by a pier of considerable robustness. It is noteworthy that two lowered arches were arranged, as the generalization of this typology was still in its infancy (Sáenz Ridruejo, 2008, 349–352). However, the selection of the scarlet arch can be justified from a technical standpoint, given the robustness of the central pier. This robustness is a result of the necessity to create a resilient element in anticipation of a potential new major flood. In this case, the most significant factor influencing the construction process was the necessity to address the high thrusts transmitted by the lowered arches. This required a simultaneous approach to shoring and stripping all the arcades. Given that the bridge was to have only two arches, this was not a significant issue. In fact, the elevation of the entire structure would simultaneously grow and develop at all points.

In any case, and despite the structural solidity of the pier, this remains a particularly delicate point, as has already been pointed out, due to the alteration it entailed on the hydraulic regime of the river, not to mention the collapse of the pre-existing bridge. However, this is the only logical explanation that would justify the asymmetry recognized at the meeting held on February 15, 1548. At this meeting, it was agreed that the first arch, the one located to the north, whose dimensions were already established, would be sized to try to leave the basin outside the riverbed for most of the year. This was done in order to avoid being so punished by the action of the waters.

In the early 20th century, José Eugenio Ribera Duraste addressed this issue, examining the collapse of numerous bridges due to the flooding of the rivers they traversed. The initial conclusion reached was that:

> *"They are almost always produced by violent floods, when the drains are insufficient* [...]. *If the bridge spans are not sufficient for the normal flood drainage, its section must be contracted. The river then calms upstream* [...]*, not recovering its normal level until a fairly large distance and downstream»* (Rivera Duraste, 1929, 45 – 46).

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This results in a notable acceleration beneath the bridge's arches, which in turn leads to the undermining of the foundation. This approach was already in use in the twentieth century, almost four hundred years after the construction of the bridge and two millennia after the majority of Roman bridges were erected. Indeed, the Romans were the first known civilization to have employed elements designed to enhance the hydrodynamic performance of their constructions. Among these elements are cutwaters, which exhibit a multitude of shapes, and channel walls. These structures serve to mitigate the impact of the bridge's narrowing on the river current, thereby facilitating the flow of water.

During the Middle Ages, the limitations of knowledge were also evident in the field of hydraulics. In the Middle Ages, bridge builders sought to minimize the impact of their structures on the riverbed, recognizing that this would help prevent potential blockages in the river flow caused by the bridge's components. In light of the aforementioned, it can be concluded that:

- In order to ensure that none of the piles remained within the channel, an even number of piles were always attempted. It is evident that this premise was not satisfied in this bridge, which does not render it exceptional. Indeed, emblematic bridges such as the Alcántara Bridge also fail to comply with this criterion. Nevertheless, it can be argued that this observation lends further support to the hypothesis previously presented regarding the asymmetry of the bridge, which was designed with the intention of leaving the intermediate pier outside the channel.

- The aim was to ensure that the work was not deviated from the main river lines. Seen on the floor (Fig. 3), the horizontal axis of the Bridge was arranged quite perpendicular to the River at the point where the Bridge was built.

- An attempt was made to arrange the arches in such a way that they would close at a level higher than that reached by the water on the main avenue.

It is important to note that this construction allowed for less flexibility in decision-making, as it was a reconstruction that aimed to replicate the existing structure. Consequently, parameters such as the height of the platform were not amenable to alteration, as they were constrained by the necessity to provide continuity to the route that the bridge was intended to serve. In the case of bridges where the starting point was from scratch, it was common practice to adjust the height of the transit platform during the construction phase according to the largest floods on record (Mesqui, 1986). This involved adapting the height of the piers and abutments to align with the established platform height.

In light of the aforementioned constraints on modifying the height of the platform, the rationale behind the decision to arrange the arches in a way that discharges at the highest possible height, thereby minimizing the potential impact of a flood, also supports the choice to forego the more prevalent semicircular arch design in favor of the lowered arch. The semicircular arch would be situated at a lower elevation, which could impede the free flow of water in the event of an elevation change.

At the time of the bridge's construction, which occurred during the Renaissance, a number of treatises on architecture were published, offering recommendations for the proper construction of bridges. The most significant of these was arguably De Re Aedificatoria by Leon Battista Alberti, which, like Vitruvius's work, comprises ten books. The work was presented by the author in 1452, which was ninety-two years before the collapse of the Pont Gère. It is not certain whether Servetus was aware of this work, although there is a possibility that he was, given the chronological proximity. It is plausible that the masters of Lyon were also familiar with it.

In chapter VI of book IV of *De Re Aedificatoria* (1992, pp. 184–191), Alberti addresses bridges, setting forth rules for their location, composition, and construction. Therefore, in light of the aforementioned assertion that the structure will remain intact for the duration of its intended lifespan, Alberti proffers the following recommendations:

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> *"Whirlpools, whirlwinds, etc., which occur in treacherous currents, must be avoided; and above all the bends [...] for in these same bends the residues, logs, and weeds that have been uprooted from the fields in the flood season are not dragged in a fluid and unhindered manner, but they pile up and, stopping one thing from another, they pile up and, after forming enormous heaps, exert pressure on the pillars, so that the eyes of the arches, obstructed, they collapse, until the construction is dislocated, due to the effect of the pressure and volume of the waters that want to pass.* […]
>
> *It is worth remembering that the stern* [downstream side] *of the pillars is more damaged by the waters than the bow* [upstream side]. *This is evidenced by the fact that the water rushes boiling more against the sterns of the pillars than against the bows; you can also see in that place eddies of great depth»* (Alberti, 1992, 185 – 187).

In addition, in accordance with the headings on the previous page, Alberti also proposed the use of an even number of piers, always conditioned by the width of the river:

> *"The number of pillars will depend on the width of the river. The odd arches are not only pleasing to the eye, but above all they provide solidity: in fact, the farther the central part of the river is from the containment exercised by the banks, the more unhindered it runs, and the more unhindered, the faster and more forceful; Consequently, at that point it must be left free, to prevent the current from affecting the solidity of the pillars when fighting against them. And the pillars will have to be located along the river, in the places where the waters run most contained and, so to speak, lazy*" (Alberti, 1992, 186).

and also

> *"the work will be given the appropriate height, with the bow and stern at an angle and the vertex raised, until the front part of the pillars is above even the level of the floods"* (Alberti, 1992, 186).

Alberti put forth design rules based on a relationship of proportionality between the span of the arches, the thickness of the piers, and the total height of the bridge. These rules would be the most widely used during the following two centuries.

Additionally, Alberti advocated for the utilization of the semicircular arch, asserting that it is "the most solid of all." However, he cautioned that if its height is excessive, "we will use the lowered [arch], after having greatly reinforced the abutments of the banks, giving them greater thickness" (Alberti, 1992, 186).

As previously noted, Savigny (1877, pp. 76–78) alluded to some leveling and crushing of the bridge in the mid-nineteenth century, yet did not specify the extent of these alterations. The aforementioned data, in conjunction with the perspective offered by the sole available image of the bridge prior to its construction (Fig. 10), precludes the possibility of verifying the original bridge's horizontality. In this regard, the Renaissance era is distinguished by a renewed emphasis on the Roman tradition, particularly in the design of bridges. The resurgence of horizontal slopes, as opposed to the more vertical profiles of medieval bridges, represents a significant departure from the traditional donkey-back shape. It is not feasible to envisage a donkey's back or an analogous curvature of the transit area, given that flatness was one of the arguments presented by the experts at the initial meeting to justify their preference for the two-arch option over the monoarch bridge ("*Aussi seroyt tropt hault et mal aysé à monter et descendre par charrectes* [sic]", Cavard, 1953, 31).

The images of the bridge that have been accessed indicate an almost horizontal grade (Fig. 2, Fig. 5, and Fig. 6), with a uniform slope from the south abutment to the north abutment (slope slightly descending from Rue des Quatre-Vents to Rue de l'Eperon). The sole image that offers insight into the bridge's pre-nineteenth-century configuration depicts a roadway that is relatively horizontal (Fig. 10).

In a transverse direction, the grade is also horizontal, as is characteristic of Roman bridges and, by imitation, Renaissance bridges (Sáenz Ridruejo, 2008, 349–352).

It is also important to note that in the field of Roman engineering, particular attention was paid to the construction of elements that would enhance the hydrodynamic performance of bridges. This was done to

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facilitate the flow of river currents and to minimize the disruption caused by the constriction of the waterway beneath the structure. Consequently, the cutwaters, which were typically triangular (or nearly so) or semicircular in plan, came to be regarded as of greater importance and prominence. In the present case, the most recent images, taken after the mid-nineteenth century, show that the cutwaters have a semicircular shape downstream (Fig. 2, Fig. 5, and Fig. 6). In contrast, the only image taken prior to this action reveals that the tajamar has a triangular floor plan upstream (Fig. 10).

In the Renaissance, this concept was also revived, bestowing upon the tajamar the engineering significance it merits. As evidenced in the analyzed images (Fig. 2, Fig. 5, and Fig. 6), the cutwaters are crowned with conical pinnacles. However, Saivgné indicated the existence of a larger central space, which he observed to be on the pile (Savigné, 1877, 76–78). This observation suggests that prior to the nineteenth-century restoration of the bridge, the tajamares may have extended to the transit platform, forming the overwidth characteristic of Renaissance bridges and often utilized as a resting place (Fernández – Ordóñez Hernández, 2008; Viollet – Le – Duc, 1854, vol. 7, 224).

Foundation

The initial challenge pertained to the methodology for constructing the foundations of the proposed bridge, particularly in light of the complexities associated with the return of water from the Rhône. The regurgitation of this water, which rose a few meters along the course of the River Gére and seeped into the designated construction area, rendered it impractical to achieve the requisite dryness prior to commencing foundation work. The issue was not merely the diversion or containment of the Gére's waters, but also the prevention of the underground transfer of Rhône waters to its tributary, given that the water would no longer circulate through it.

Once again, we are indebted to Cavard for his meticulous research, which led him to the archives of Vienne (Cavard, 1953). These archives revealed that Servetus initially intended to wait for the waters to recede before commencing work on the bridge or, at the very least, to await the descent and conduct further studies on the optimal methodology for its construction. According to the records, Servetus himself transferred it in a session held on May 27, 1552 (the last Tuesday of the month):

> *"Du mardy dernier de may l'an mil cinq cens cinquante deux, dans la mayson consulaire de Vienne et en après au dessoubz le pont de Gière, assemblés* [...] *Led. seigneur de Villeneufve a bailhé par escript certains mouyens par lesquelz on pouroict mectre à scec le lieu où l'on prétend fonder la pille dud. pont de Gière. Et après avoyr du tout faict lecture et longue-ment disputé des quatre mouyens mys en avant, a esté dict que, actandu la grandeur de l'eau du Rosne qui regurgite contremont lad. rivière de Gière, empeschant à l'exéquution prétandue, que pour maintenant on n'y fera aultre chose, attendant la descreue dud. Rosne, et que ce pendant on continuera à la plantailhe des paulx en lad. fondation* [sic]" (Cavard, 1953, 33 – 34).

This decision was therefore made at the onset of summer when the water level of the river would be at its lowest point.

In a subsequent assembly convened on May 31 of the same year, 1552, the construction procedure to be followed in order to maintain the foundations of the work that was being begun in appropriate conditions of dryness was discussed. It is known that four or five high-ranking personalities from the fields of politics and local administration in Vienna were in attendance at the meeting. It is also known that Doctor Mercat was among these personalities, but there is no evidence that Servetus was present (Cavard, 1953, 31–34). The meeting concluded without a definitive resolution, resulting in the postponement of a crucial decision.

In the latter part of the summer, on July 4, 1552, Doctor Miguel de Villanueva proposed to the master builders, masons, and carpenters who had come from Lyon a method for diverting the water from the Rhône, which had been regurgitating at the point where the work was to be carried out. This proposal also included a procedure for building a platform to ensure the base of the two new constituent arches of the bridge. This occurred during the visit by the aforementioned professionals, who came to Vienne to inspect the auxiliary means that were already available, and in particular the trusses that were going to be used for

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the shaping of the arches. The masters were likely interested in recognizing the trusses due to the intention of simultaneously constructing the two constituent vaults of the bridge, a strategy aimed at enhancing its overall stability, as previously discussed.

Upon completion of this assessment, the consuls, preoccupied with the challenges posed by the water and unable to identify an optimal and dependable technical solution, requested the operators to conduct an on-site investigation. This is what they did, accompanied by Michael Servetus:

> *"Et après, en présence de Mons^r de Villeneufve, ont dict qu'il seroyt (bon) de oster, tant qu'il seroyt posible, l'eau estant au lieu de la pille et, en après, pousser plus avant les paulx ainsi plantés et commancer à massonner, sans se arrester au dire dud. s^r de Villeneufve qui vouldroist faire des tranchéez en la rivière pour divertyr l'eau qui sort aud. lieu de fondation de pille. Bien trouvent ilz bon de faire le nyvellage que diroyt led. S^r de Villeneufve, puis la creue du Rosne jusques à l'eaue estant en lad. fondation, pour sçavoyr de combien led. Rosne seroyt plus bas que l'eau de lad. fondacion* [sic]*"* (Cavard, 1953, 34).

As can be observed, Servetus proposed, during an on-site visit, the excavation of trenches in the ground around the planned location of the intermediate support pier for the bridge. The proposed trenches would, in the most favorable circumstances, permit the diversion of water from the Rhône, which flowed from the point where the pier foundation was to be constructed, thereby rendering it impossible to proceed with the foundation work. In the least favorable circumstances, such excavations would provide an opportunity to ascertain the precise moment when the Rhône waters reached the construction site at a lower level, thus indicating the optimal time for intervention.

Subsequent events demonstrate the prudence of this Servetian methodology, as the quantity of soil that was necessary to excavate in order to ensure the long-awaited watertightness was considerable. Indeed, Cavard recounts how on the following day, July 5, 1552, several distinguished individuals convened with the master masons and carpenters of Vienne at the consular residence. At the aforementioned meeting, the consuls demanded that, in accordance with the recommendations provided by the experts who had arrived from Lyon, they proceed with the implementation of the proposed earthwork, which would facilitate the necessary drainage.

> *"They would have worked to tyre the water from the foundation of the pile by trumpets Ils auroyent faict travailher à tyrer l'eau de la fondation de la pille par trompes et aultrement, et que lesd. maistres et aultres (de Vienne) auroyent dict qu'aujourd'huy lesd. trompes n'y servent de rien ou si peu et qu'il vouldroict mieulx les oster de là et travailher à bennes, requerantz tous les susnommez se transpourter sur led. lieu pour sur ce y conclure ce que de rayson. Et estans sur le lieu et avoyr veu et visité lesd. trompes qui de peu servent le grand nombre de gens y travailhant, a esté conclud que l'on ostera toutes les trompes et fera on travailher à bennes pour voyr s'il y aura mouyen de égotter et mectre à sec led. lieu. Et se fera unz bleton, là où est la soursse de l'eau du cousté de St Sevez* [sic]*"* (Cavard, 1953, 34).

Again, it was inevitable to look back to the past Roman times in terms of the construction of the foundations, as the Romans laid the foundations for their constructions

> *"sur un sol résistant, au moyen de larges blocages qui forment, sous les constructions, des empattements homogènes, solides, composés de débris de pierres, de cailloux, quelquefois de fragments de terre cuite et d'un mortier excellent. Les fondations romaines sont de véritables rochers factices sur lesquels on pouvait asseoir les bâtisses les plus lourdes sans craindre les ruptures et les tassements. D'ailleurs la construction romaine étant concrète, sans élasticité, il fallait nécessairement l'établir sur des bases immuables"* (Viollet – Le – Duc, 1854, vol 5, 524).

Viollet-Lé-Duc, the author of the aforementioned statement, was aware that a considerable number of structures were constructed with excessive use of cement during the Middle Ages, particularly during the Romanesque era. Many of these structures were ultimately demolished.

It is therefore logical that Servetus and the Lyon masters sought to create the necessary means to form the artificial rock ("rochers factices") and the immutable base ("immutable bases"), to which Viollet-Le-Duc referred, on which to raise the central support of the bridge without fear of any kind of breakage or

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settlement ("sans craindre les ruptures et les tassements"). The primary objective was to reduce the presence of water.

In order to construct the foundations within the riverbed, the Romans would either divert the river's entire course or dam it during the dry season. They would then create provisional dams to contain the river's current. Alternatively, they would employ simple construction techniques to create dry enclosures, allowing them to settle ashlars on firm and consistent soil strata. These procedures included the use of wooden pile screens or provisional earth cofferdams, which were drained by draining the water that filtered into the enclosure with hydraulic devices, such as the Archimedes screw or similar (Golvin & Coulon, 2021, 72).

In the aforementioned work, Vitruvius recommended the excavation of trenches to identify a suitable foundation site. If such a site was identified, it was advised that the foundations be constructed with the greatest possible solidity, and with a width greater than that of the elements to be supported.

> *«Fundationes eorum operum fodiantur, si queat inveniri, ab solido et in solidum, quantum ex amplitudine operis pro ratione videbitur, extruaturque structura totum solum quam solidissima. Supraque terram parietes extruantur sub columnas dimidio crassiores quam columnae sunt futurae, uti firmiora sint inferiora superioribus; quae stereobates appellantur, nam excipiunt onera*
>
> […]
>
> *Sin autem solidum non invenietur, sed locus erit congesticius ad imum aut paluster, tunc is locus fodiatur exinaniaturque et palis alneis aut oleagineis (aut) robusteis ustilatis configatur, sublicaque machinis adigatur quam creberrime, carbonibusque expleantur intervalla palorum, et tunc structuris solidissimis fundamenta impleantur.*
>
> *Exstructis autem fundamentis ad libramentum stylobatae sunt conlocandae»* (Vitrubio Polión, nd).

It is evident that Vitruvius makes no mention of depth, perhaps because he assumes that the characteristics of the terrain, at a geotechnical level, are inherently improving with depth. It is therefore imperative to commence excavation, particularly in the presence of water.

During the Middle Ages, Roman engineering technology and knowledge either stagnated or disappeared. The peoples who inhabited central Europe (and particularly France) after the fall of the Roman Empire did not contribute new arts or original procedures to the art of construction until the arrival of the Gothic. Instead, they limited themselves to imitating the monuments that the Romans left after the barbarian invasion.

In the context of this technical obscurity, the Mappae Claviculae merits particular attention. This document, dating from the eighth century AD, offers significant insights into technical practices of the period. The document also contains a reproduction of a Roman surface foundation system, as outlined in the text Dispositio fabricae de pontibus (Mesqui, 1986, 229). The document indicated a quarter of the total height of the structure as a reference for the depth of the foundation, and also advised, as Vitruvius had previously done, that firm ground should be sought. It is similarly unfeasible to ascertain whether Servetus was aware of the contents of the Mappae Claviculae pertaining to the foundations. However, it is noteworthy that this document prompted us to exercise caution when assessing the stability of soils intermingled with stones, a common occurrence in riverbeds. Such mixtures can impart an unwarranted perception of solidity. In this regard, Viollet-Le-Duc associated the problems of the foundations of certain Romanesque monuments with the arrangement of their foundations on soils made up of ancient sediments or sediments carried and deposited by the waters and on flooded soils or with a high presence of water (Viollet – Le – Duc, 1854, vol. 5, pp. 524–528).

In other instances within Roman construction, the formation of an immutable base for an inelastic structure was achieved through the arrangement of a primary row of ashlars comprising lying stone materials or, more frequently, multiple rows of ashlars set back slightly from the underlying course (Choisy, 1999). This resulted in the formation of a slight escarpment, which provided additional support for the foundation. The

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final support section of the pier was increased, as the lowest part, which rested on the ground, was reinforced. Furthermore, the hydraulic behavior of the construction was enhanced, as the thickness of the pier's base was reduced as the height increased, thereby expanding the section available for the transit of river currents. This aspect was of great interest in the context of rebuilding a bridge destroyed by a flood, given the considerable volume of water that the river could transport.

It is also noteworthy that, when the terrain was deemed unsuitable and its bearing capacity was in question, the Romans employed a similar strategy to that described above, namely, improving the soil. This was achieved by using breakwaters or forming layers of concrete with lime and pebbles. The result was a foundation that was comparable to the long-awaited artificial rock, which would serve as an immutable base that would later be cemented. In the aforementioned work, Alberti advised that the bridge should not be erected on "unstable ground," but rather on a level and firm foundation (Alberti, 1992, 185).

On August 19, 1552, the first stone of the future bridge over the River Gère was laid in an act of great solemnity. The written testimonies analyzed and the sources consulted do not provide clarity regarding Michael Servetus's attendance at this ceremony (Cavard, 1953). It is known, however, that the workers followed the advice given by Servetus and finally executed the trenches that he had proposed during his visit on July 4, 1552. This allowed the foundation of the pier of the new bridge to be laid in inadequate conditions, which would remain standing for more than four hundred years.

The construction of the bridge was overseen by Reynaud Barlet, who proceeded at a slow and deliberate pace. The bridge was ultimately completed and opened to traffic during the final months of 1557.

Conclusions

On August 19, 1552, in a ceremony marked by solemnity, the first stone of the future bridge over the Gère River was laid. This bridge would remain standing for more than four hundred years. The pace of the work was consistent with the gradual pace observed during the initial planning stages. The construction process spanned a period of five years, with the bridge not being opened to traffic until the end of 1557.

As has been previously discussed, Michael Servetus played a dual role in the design and initial construction of the bridge that spanned the Gère River. Firstly, he was responsible for determining whether the bridge should be constructed with a single arch or a double arch, necessitating the inclusion of an intermediate support pier.

The second phase of Servetus's involvement commenced upon the commencement of construction. He visited the site with the workers (masons and carpenters) to ascertain the optimal method for laying the foundations of the pilaster, which would serve as the basis for the intermediate support. To this end, Servetus finally advised the execution of trenches that would allow the water of the river to be diverted from the point where the foundation of the pier had been projected. The builders followed this advice, and the result was a bridge that fulfilled its intended purpose and remained standing for over four centuries. It was not natural causes that led to its demise, but rather the actions of humans. Indeed, the action taken in the nineteenth century was undertaken with the objective of adapting the bridge's functionality to accommodate traffic and the emerging demands of the surrounding environment. It was not driven by concerns related to loss of resistance, collapse, or structural failure of the bridge. From a structural standpoint, the bridge remained intact.

Michael Servetus did not live to see the completion of the work in which he had played such an active role. By this time, he had already escaped from Vienna, where he had been tried and would later be burned in effigy, and had already been recognized, imprisoned, tried, and burned in Geneva. It is noteworthy that Servetus crossed the River Gère at another point in order to flee Vienne and reach Geneva.

Nevertheless, the findings of this research demonstrate that Michael Servetus's involvement in the reconstruction of the bridge was not merely passive, but also instrumental to its success. The approaches and reasoning he proposed, aimed at addressing the technical challenges posed by such a monumental

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undertaking, attest to his profound understanding of engineering and his remarkable aptitude for problem-solving.

References

(Alberti, 1992) Alberti, Leon Battista, De Re Aedificatoria. Madrid, Ediciones Akal, 1992.

(Arribas Salaberri, 1974) Arribas Salaberri, Julio, Miguel Servet, Concejal. Lérida, Gráficas Larrosa, 1974.

(Arribas Salaberri, 1976) Arribas Salaberri, Julio, Miguel Servet. Geógrafo, Astrónomo y Astrólogo. Lérida, Gráficas Larrosa, 1976.

(Barón Fernández, 1971) Barón Fernández, José, Miguel Servet: su vida y su obra. Madrid, Espasa – Calpe, 1970.

(Brisaud, 2018) Brissaud, Laurence, Le franchissement du fleuve à Vienne. Suplemento de Revue Archéologique de Narbonnaise nº 48. Montpellier, Association de la Revue Archéologique de Narbonnaise, 2018.

(Cavard, 1953) Cavard, Pierre, Le Procès de Michel Servet a Vienne. Viena, Syndicat d'Initiative, 1953.

(Choisy, 1999) Choisy, August, El arte de construir en Roma. Madrid, Instituto Juan de Herrera, 1999.

(Chorier, 1828) Chorier, Nicolas, Recherches sur les antiquités de la ville de Vienne, metropole des Allobroges, capitale de l'empire romain dans les Gaules et des deux royaumes de Bourgogne. Lyon, Chez Millon Jeune Libraire, 1828. Available online: https://books.google.fr/books?id=yCJGAAAAMAAJ&pg=PA479#v=onepage&q&f=true.

(Cremades Sanz – Pastor, 2008) Cremades Sanz – Pastor, Juan Antonio, Miguel Servet en Francia. El exilio forzoso de un pensador aragonés. Zaragoza, El Justicia de Aragón, 2008.

(Drummond, 1848) Drummond, William Hamilton, The Life of Michael Servetus: The Spanish Physician, Who, for the Alleged Crime of Heresy, was Entrapped, Imprisoned, and Burned by John Calvin the Reformer, in the City of Geneva, October 27, 1553. Londres, John Chapman, 1848. Available online: https://books.google.es/books?id=CyQEAAAAQAAJ&printsec=frontcover&hl=es&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false.

(Fernández – Ordóñez Hernández, 2008) Fernández – Ordóñez Hernández, David, «Puentes en el Renacimiento». El Nuevo Miliario, 7, December 2008. Madrid, Fundación Juanelo Turriano, 2008. Available online: https://amp.issuu.com/juaneloturriano/docs/el_nuevo_miliario_7_2008/s/10635209.

(Fuentes Sagaz, 1999) Fuentes Sagaz, Manuel de, Miguel Servet (1511 - 1553). Barcelona, Uriach, 1999.

(García Barrón, 2000, 137 – 150) García Barrón, Leoncio, «Fundamentos físicos de la construcción medieval: arcos y puentes», en Graciani García, Ámparo (coord.), La Técnica de la Arquitectura Medieval, Sevilla, Universidad de Sevilla, 2000; 137 – 150.

(González Echevarría, 2011) González Echevarría, Francisco Javier, El amor a la verdad. Vida y obra de Miguel Servet. Tudela, Gobierno de Navarra, 2011.

(Golvin & Coulon, 2021) Golvin, Jean – Claude; Coulon, Gérard, La ingeniería del ejército romano. Madrid, Ediciones Desperta Ferro, 2021.

(Heyman, 1999) Heyman, Jacques, El esqueleto de piedra. Mecánica de la arquitectura de fábrica. Madrid, Instituto Juan de Herrera, 1999.

(Martínez Laínez, 1976) Martínez Laínez, Fernando, Caminos abiertos por Miguel Servet. Madrid, Editorial Hernando, 1976.

(Mas – Guindal Lafarga, 2011) Mas – Guindal Lafarga, Antonio José, Mecánica de las estructuras antiguas o cuando las estructuras no se calculaban. Madrid, Munilla – Lería, 2011.

(Mesqui, 1986) Mesqui, Jean, Le Pont en France Avant le Temps des Ingenieurs. Paris, Picard, 1986.

(Morón Bueno, 2008) Morón Bueno, Ramón, «A propósito de un retrato de Miguel Servet», en Betés, Luis (ed.) Estudios sobre Miguel Servet (III). Zaragoza, Instituto Educación Secundaria Miguel Servet, 2008. Available online: http://www.iesmiguelservet.es/wp-content/uploads/2015/12/Estudios-sobre-Miguel-Servet-III.pdf.

(Rivera Duraste, 1929) Rivera Dutaste, José Eugenio, Puentes de fábrica y hormigón armado. Tomo III: Anteproyectos y puentes de fábrica. Madrid, Sucesores de Rivadeneyra, 1929. Available online: http://juaneloturriano.oaistore.es/opac/ficha.php?informatico=00000236MO&idpag=242883642&codopac=OPJUA.

(Sáenz Ridruejo, 2008) Sáenz Ridruejo, Fernando, «Ingeniería y obra pública civil», en Silva Suárez, Manuel (ed.), El Renacimiento: De la técnica imperial y la popular, Zaragoza, Institución Fernando el Católico, 2008; 345 – 382. Available online: https://ifc.dpz.es/recursos/publicaciones/28/72/_ebook.pdf.

(Sanz Agüero, 1973) Sanz Agüero, Marcos, «Miguel Servet», en Michal, Bernard (coord.), Grandes Enigmas Históricos de Antaño, Madrid, Los Amigos de la Historia, 1973; 77 – 161.

(Savigné, 1877) Savigné, Ennemond – Joseph, Guide à Vienne (Isère): Histoire, Biographie, Musée. Viena, Edited by the author, 1877; 76 – 78 (available online: https://books.google.es/books?id=GXMljhlHY_4C&printsec=frontcover&hl=es&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false).

(Servet, 2003) Servet, Miguel, Obras Completas. Vol I. Vida, Muerte y Obra. La lucha por la libertad de conciencia. Documentos. Zaragoza, Prensas Universitarias de Zaragoza, 2003.

(Servet, 1971) Servet, Miguel, Treinta Cartas a Calvino. Sesenta Signos del Anticristo. Apología de Melanchton. Madrid, Editorial Castalia, 1971.

(Viollet – Le – Duc, 1996) Viollet-le-Duc, Eugène, La construcción medieval. Madrid, Instituto Juan de Herrera, 1996.

(Viollet – Le – Duc, 1854) Viollet-le-Duc, Eugène, Dictionnaire de l'architecture française du XIe au XVIe siècle. Paris, B. Bance Éditeur, 1854 (available online: https://books.google.es/books?id=AysDAAAAQAAJ&printsec=frontcover&dq=viollet+le+duc+Dictionnaire+

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raisonné+de+l%27architecture+française+du+XIe+au+XVIe+siècle&hl=es&sa=X&redir_esc=y#v=onepage&q&f=false).
(Vitrubio Polión, 1995) Vitrubio Polión, Marco Lucio, Los diez libros de la Arquitectura. Madrid, Alianza Editorial, 1995.
(Vitrubio Polión, nd) Vitrubio Polión, Marco Lucio, De architectura Libri X. http://www.vitruvius.be/index.htm.
(VVAA, 2013) VVAA, «Les ponts du mois de mai: une existence mouvementée sur la Gère». Le dauphiné Libéré, May 9, 2020. Available online: https://c.ledauphine.com/isere-nord/2013/02/02/decouvrez-vienne-au-debut-du-xxe-siecle.
(VVAA, 2020) VVAA, «Découvrez Vienne au début du XXe siècle». Le dauphiné Libéré, February 15, 2013. https://c.ledauphine.com/edition-vienne-nord-isere/2020/05/09/les-ponts-du-mois-de-mai-une-existence-mouvementee-sur-la-gere.