XII CONFERENCE ON STEEL AND COMPOSITE CONSTRUCTION

PROJECT: HOSPITAL MATER DEI SALVADOR

DIRECTORY 2019 STEEL AND COMPOSITE CONSTRUCTION
From Lisbon to the Other Side: the bridge mirage

“A great city with water barriers and no bridges is like a skyscraper with no elevators. Bridges are a monument to progress.”

Joseph Strauss*

Since immemorial time, crossing a river has been an enormous human challenge. The implementation of any constructed artefact, overcoming the physical abyss, aided by the calm or turbulent waters of the rivers, constituting a barrier to full contact between banks was, from an early age, an obstacle that seduced minds by offering a fertile field for shrewdness. The intrinsic potential associated with the use of steel structures supported by scientific evidence and by physical and mathematical laws gave rise to numerous solutions that seemed easy to suppress gravity, making it possible to achieve what for a long time could be seen as utopia.

This eagerness to overcome obstacles was an opportunity that mobilized many resources, especially intellectual ones, leveraging numerous successes, but also some failures. In the case of Lisbon, which was not different from others, there was the circumstance that the banks were particularly distant and that there was the immensity of a river that greatly limited the development of the sides, it was an evidence that the technique and the economic capacities, unfortunately, delayed the resolution.

For climatic reasons, and also for utility, the Lisbon experiences were almost always in the sense of taking little advantage of the river. In addition to the logistical and port issues, urban life had a development that did not prioritize the potential of the Tagus estuary and looked at the waterway as a very conditioning physical barrier. If after the 1755 earthquake the Pombaline design tried to organize part of the destroyed city, creating a monumental axis that chose the Tagus as an important element made in Praça do Comércio, the later developments of the city were unmistakably

triggered in a logic of backs facing the river. This was what happened during the eight hundredth period, as there was an enormous pressure on the availability of buildable soil and the urban models used were inevitably very marked by Haussmann’s plan in Paris, which resulted in the layout of the structuring Avenida da Liberdade, with the subsequent strategic enhancement of land to the south of the city.†

Figure 1. Excerpt from a map of the Lisbon region, partial reproduction of the Maritime Atlas of Spain by Vincente Toñino de San Miguel (1732-1797), dated 1787, published in London in 1812.

Despite the dimension of the width of the Tagus River in the Lisbon area, it does not appear that this circumstance was an insurmountable condition and that, therefore, it contributed to the dynamics being limited to one of the margins of the waterway. The pace and intensity of the crossings will have resulted from the existing means to make it happen. Until 1821, successive crossings were carried out using sailing boats and only after that year were they

* Chief Engineer of the Golden Gate Bridge, quote from Donald MacDonald and Ina Nadel, Golden Gate Bridge, Chronicle Books, San Francisco, 2008, p. 4.
implemented with the first steamboat. This means of transport was considered, at the time, the fastest and most economical means of transportation. With the development of the railroad, it quickly assumed itself as strategically relevant, which led to its national expansion, forcing it to question the policy of rapid circulation and the study of crossing rivers when these constituted an obstacle to the progress of transport.²

The discussion of the need for a bridge over the Tagus near the city of Lisbon is closely related to the integrated development of the national rail network, which began in 1852. At that time, the railroad was assumed as the fastest means of transport and the most credible to leverage the country’s development.³ A part of the narrative that involves the intense use of steel structures is closely linked to the evolutionary process of transport where the railway aspect, as it appears, is of particular relevance. The topographical accidents and the conditions of very low inclinations associated

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³ The railroad introduced a profound change in the models and times of circulation in the country. The existing road network was very fragile and dependent on weather conditions, making it virtually impassable in winter. The train also brought a new concept, which was that of punctuality and time compliance.

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with the railways, were a constant challenge that led, on the one hand, to the design of structures that were easy to assemble and withstand the enormous loads derived from the carriages and locomotives, having been iron the resource chosen as the most plausible...
to solve this intricate equation. On the other hand, it led that, starting from the New Estate, all evaluations that presupposed circulation network strategies in the country started to consider this new road as a privileged form of locomotion, mainly because the road network was more versatile and diverse than the particularity of the railways.

Historically, engineer Miguel Pais, in 1876, and in the reign of D. Luís I, was responsible for preparing the first study of a bridge over the Tagus in order to resolve circulation between banks, in this case linking Grilo (Lisbon) to Montijo (former Galician village of Ribatejo).

This solution would allow an articulation with the southeastern railway branch (Pinhal Novo station) and help define an alignment from Setúbal to the Algarve. This crossing was a very consistent idea that Miguel Pais himself presented to the Association of Civil Engineers on October 7, 1876 and which deserved a reasonable welcome from the community.6 This study, based primarily on solving the problem of railways, given that it was the fastest means of transport at the time, had the particularity of developing in a place with greater distance between banks, which the author defended with the technical added value that in that place the river has less depth and therefore it is easier to implement foundations and there is less need of height of the deck in relation to the river, in addition to the fact that the bridge is within reach of the artillery.7 This bold proposal for the time, in masonry and iron, would have a length of about 4,500 m divided by 74 spans of 60 m and one at each end of 48 m, it would have two overlapping trusses, one upper for ordinary road and one lower for a railroad, leading the most incredulous to suppose that such speed could be close to any Jules Verne novel.8

In reality, that proposal had some similarities with the railroad bridge that was to be completed two years later in Viana do Castelo - designated as the Eiffel Bridge in honor of its author - whose project: Miguel Pais knew to some detail and conceptually assumed some functional similarities.9 In addition to this case, Miguel Pais gave as examples of the potential to overcome large spans through the use of steel structures plus two recent examples located in Scotland, namely a bridge over the River Tay10 and another over the River Forth.11 In addition to these references, there seems to have also been some influence from the suspension bridge over the River Conway completed in 1826 and the Britannia tubular bridge completed in 1846 - both in Wales - both in materiality and in the use of gothic revival ornamental elements.12

Miguel Pais was a visionary character, with enormous attachment to the city of Lisbon, which is why he derived to the presentation of a vast set of proposals aimed at improving it. Through articles published regularly in the Diário de Notícias, this author regularly exposed his views through which he intended to transform Lisbon into a cosmopolitan city, with a harmonious and integrated development. The latter, not being confined to the area already built, should develop in a sustainable way to other peripheries, including on the south bank of the Tagus, where it proposed to move the Navy Arsenal, decongesting on the north bank an area of vital importance for road circulation and functions more adjusted to urbanity.13 The investment of the bridge over the Tagus becomes even more relevant when, from 1877, after the construction of the Maria Pia Bridge over the Douro River, the Lisbon railways were linked to Porto with the provinces of Minho and Douro,
giving greater meaning and relevance to its integrated extension to the Alentejo and Algarve, whose access from Lisbon was normally done by sea and, obviously, very dependent on the weather.14

In 1888, an American engineer named Lye aspired to connect, by bridge, Almada to Tesouro Velho, in Lisbon, articulated with a railway station located in Largo do Chiado, known at the time as Largo das Duas Igrejas.15 This idea of physically connecting the two banks has become more and more a conviction, since the limit of growth of the city conditioned to one side was perceived. As a result of engineering developments, it was beginning to be plausible to win that water front, believing in the realization of the same city extended to both sides of the Tagus, even speaking of the creation of two Lisbons.16

Shortly after, another study followed, developed under the proposal of Edmond Bartissol and Théophile Seyrig, in 1889, with the design of a steel arch bridge, connecting the Rocha do Conde de Óbidos area to Casilhas. Such a proposal was quite credible because Seyrig was the builder of the D. Luís bridge in Porto, a fact that made the possibility of building a 2,310m long bridge even more plausible, complemented by a railway line that would connect the Rossio station to Barreiro. This proposal, defined by a set of steel arched spans, with spacing between pillars of variable dimensions (115, 160 and 300m), presented a board 18m wide,
the narrowest part of the river - which, combined with generous spacing between pillars, would favor a continuity in the circulation of transatlantic or high-rigged ships.19

Bartissol/Seyrig’s solution was not at all peaceful, it generated a lot of controversy, giving rise to the fact that engineer André de Proença Vieira, based on an opinion by geologist Paul Choffat, was very critical of Seyrig’s proposal and in 1890 defended the suggestion by a German firm, from Nuremberg, Maschinenbau-Aktien-Gesellschaft, which saw the connection between Montijo - more precisely Quinta da Mitra - and Beato as the most reliable solution.20 This bridge with a layout very close to that of Miguel Pais, was developed in beams of the type “cantilever”, based on masonry pillars defining spans of 200m and deck at a height of 20m in relation to the average level of the river waters.21 These characteristics are indicative of the little importance attributed to the navigability of the river, which probably resulted from the fact that the bridge is upstream of the port of Lisbon and that, practically from the place of its implantation, the river decreases in depth and makes this issue less relevant.22

part of which was destined for rail transit and part for ordinary transit.23 In this proposal, the necessary articulation between the new central station under construction in Rossio and Rocha do Conde de Óbidos (location of the station where the railway line of the proposed bridge ended) would be ensured through a vertical lift or a cable railway, ensuring the connection function of the network, but not the physical connection of the compositions.24

If Miguel Pais had chosen to build his bridge in the wider area of the watercourse, Bartissol / Seyrig argued that this possibility was very limiting for the circulation of ships upstream of Lisbon, which would require the implementation of rotating bridges, a situation that was not contemplated. Inspired by analogy to cases in London, the Netherlands and America, Bartissol / Seyrig showed little concern with the problem of the depth of the foundations and, due to the natural existence of hills and the possibility of freeing the low margins, they strongly defended the possibility of working on

17 Costa, L. Mendonça da, “Improvement of Lisbon, Bridge over the Tagus O Ocidente, Revista da Arquitectura de Portugal e Estrangeiro, n°380, July 11, 1889, p. 115, For a more detailed description of the project, see Bartissol, Edmond and Seyrig, Théophile, The Tagus Crossing in Lisbon.
18 Bartissol, Edmond and Seyrig, Théophile, The Tagus Crossing in Lisbon, p. 16,
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At the beginning of the 20th century, more precisely in the year 1906, Fialho de Almeida, in a pair of articles published in the magazine *The Portuguese Illustration*, described a set of utopian proposals for Lisbon, where highlight was given to the construction of a bridge that could connect the banks of the Tagus, making both sides of the river function as a single city. This proposal intended to put some order in the amalgam of city functions, pushing commercial and industrial Lisbon to the left bank and guaranteeing the connection between the two banks by a crossing that was intended to be made by train or pedestrian. This ambitious project would offer a subsequent spatial zoning, allowing the traditional city to be freed as much as possible and slowly clearing the seaside of the panoply of structures and infrastructures that sealed the banks of the Tagus from Lisbon. This Great Lisbon, rhythmic by a railroad dream, would be exchanged for a metropolis that did not know how to adequately enhance the possible logistics on both banks giving priority to road circulation. In this sense, the functions were not organized sufficiently, the left and right margins were moving at the pace of convenience and certainly made the populations be kept well away from the frank relationship with the Tagus.

Despite a wide variety of studies, the bridge was delayed in its completion and the alternative was river transport. Since the projects are many and diversified, some were nothing more than mere intentions, others corresponded to solutions with great feasibility, but the economic and development conditions of the country were a brake that sent all these proposals to the order of visionary dreams that failed to pass to the desired practice. In the Portuguese case, we have to see that, both the process of transition from the monarchy to the republican regime, and the later proximity of the first major world conflict, were extreme events that certainly conditioned the country’s finances to a great extent and constituted an immeasurable brake on more progressive trends based on resources that the country did not have.

In the same year of 1906, engineer José Maria de Mello e Matos was rehearsing in the last of a series of four fictional texts, the operation of a tunnel that connected Lisbon to Seixal. The suggestive title of the article in *The Portuguese Illustration*, referred to the imagined event described by the Tagus underground crossing taking place in the year 2000. The remarkable engineering work that that prose predicted, revealing the great inventive spirit of the author, would end in 1994, clearly assuming itself as an alternative to the possibility of using a bridge. With the subtitle “The tunnel to the other side”, the text is particularly interesting because the description elucidates the technical knowledge of its author, focusing on the process of a work of such a demanding task and constituting a pretext to sublime national engineering in their capacity for entrepreneurship and technicality. Interestingly, reading the four articles does not offer any clue as to how the city, however, could have been structured and developed in its organizational and urban aspect. However, both the description and the engravings that accompany the various texts, present images of a hypothetical modern and cosmopolitan city, taking advantage of electricity, very marked by the presence of the railway lines, by cars, a subway with suspended carriages and a sky filled with airships, which Mello e Matos called airplanes.

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25 The four texts that appear in the weekly publication *Portuguese Illustration* under the title “Lisbon in the year 2000”, correspond to the numbers 6 (March 28), 7 (April 11) and 8 (April 18) of 1906, published in Lisbon in 1906.
26 “Lisboa in 2000 - The tunnel for the other side”, *Portuguese Illustration*, II serie, nº 6, pp. 243-249.
Following a progressive logic, the theme of the connection to Almada, in addition to the models of ordered growth in the city of Lisbon, was a hot topic both in the press and in the authorities. With accuracy and in his condition as a councillor in the Lisbon City Council, the architect Miguel Ventura Terra noted the crossing as a form of harmonious and urban growth, since the plans for the riverside area should be structured by a *monumental avenue bridge* allowing the other side to be a city of leisure. As a curiosity, it is worth mentioning Ventura Terra’s environmental vision, as he already recommended the planting of trees, helping to tone the atmosphere and to create comfortable spaces for its users. 28

Therefore, the idea began to be drawn that the left bank of the Tagus, mainly the beach area facing the Atlantic, constituted a privileged space for the summer. In 1913, Madureira Chaves, an illustrious general in the reserve, stated that a work such as the bridge over the Tagus was an imperative condition for tourism development, since it would allow a structuring route that would establish strong ties, in railway terms, of the opposite national geographic poles. This soldier even defended the creation of residential centers for foreigners, organized by origin, proposing an international city for the Lisbon - Barreiro - Setúbal triangle. 29

In 1919 a hypothesis developed by the company H. Burnay & Cia was developed, which was the construction of a 4,500m long tunnel with a corridor between Santa Apoeléia and Cacilhas, but which would certainly have a very frequent maintenance beyond all complex chargeable technical issues.

Two years later, it would be the prestigious Spanish engineer Alfonso Peña Boeuf who would take the dedicated study of developing a crossing between the Santos and Cacilhas area, but that will be the part, as well as the other stories that will follow, that remain promised to tell later in the next issue of the magazine.