TECHNICAL: SOLUTIONS USING STEEL STRUCTURES IN GEOTECHNICAL REHABILITATION WORKS IN URBAN AREAS
The Bridge between Lisbon and the Other Side: Continuity of a dream*

Before the “25 de Abril” Bridge was dreamed, designed and built, the Tagus was a fast track in permanent traffic jam."
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João Pedro Pinha**

While the bridge was a mirage, the boat made it possible to cross between Lisbon and the other bank. In fact, since there was no way to provide a direct link between Olisipo and the left side of the Tagus, the waters of the river offered the most expeditious and obvious way to make room for the displacement of people and goods. Until the middle of the 19th century, there were more than 3,000 boats registered in the space of the Tagus estuary, knowing that the crossing preferences fell, predominantly, on solutions propelled by canopies, since this solution was the one that offered the fastest crossing. Depending on the needs, the vessels could be large, such as frigates and “vannos” (Long and narrow boats used in the Tagus), or of a more moderate size, such as boats, canoes, “faluas” (cargo vessels) and “catrisos” (small, robust vessel with oars and triangular sail). The industrial revolution and the technological development associated with it made the reality of steam locomotion possible, with the first boats appearing on the Tagus, powered by this energy, around the sixties of the 19th century. If the beginning of the twentieth century, more precisely in 1903, brought the transport of motor vehicles, this being ensured by the well-known ferry boats, it would be necessary to arrive in the year 1931 to see the immortalized sailors, boats powered by diesel engines.¹ These boats, which owe their name to the circumstance of allowing the connection between Cais das Colunas and later from Cais do Sodré to Cacilhas (Almada), later became popular offering new and varied places of boarding.

If inland waterway transport constitutes, as it is currently maintained, a crucial means of transport in the pulverized connection between different points of the two banks, the popularization of the train and then the car were certainly determining factors for the development of an awareness of the need to find a more stable way of crossing and less dependent on climatic aspects or light cycles. Hence, until the completion of the so-called Salazar Bridge, studies are recurrent, projects aimed at solving a problem that was somehow considered technically feasible, but probably presented itself as economically poorly adjusted to the capabilities of a remedied country that no longer it could count on the wealth of Brazil and that it had to look at its “colonies” as an investment space. However, knowing that hope is the last to die, in the twentieth century a whole set of proposals will follow that will allow us to foster strategic and visionary visions.

Undoubtedly, an actor who deserves to be highlighted in his effort to solve the problem of crossing the Tagus River from Lisbon is, unmistakably, the Spanish

* Continuation of the article “From Lisbon to the Other Side: the bridge’s mirage”, published in number 56 of the Metisica magazine.
** Quote taken from the article “When the margins of the Tagus”, Jornal Observador, August 5, 2016.
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engineer Alfonso Peña Boeuf. In 1921, Peña Boeuf, in co-authorship with the Portuguese engineer Henrique Pereira Pinto Bravo (inspector of the Superior Council for Public Works), proposed the development of a road-rail solution, with a single deck in reinforced concrete with 14 parabolic arches of 150m span and 40m arrow. This project, which presupposed four roads for road circulation and two railways, was widely discussed in Parliament, but rejected by the government at the time. The truth is that, at that time, the rail network needed a more direct connection between Barreiro and Lisbon, since the only possible connection – according to Peña Boeuf – required a contour of more than 150km². Its proposed bridge, to be launched between Jardim de Santos and the point of Cacilhas, was at a height of 45m from the river, forcing that on the Lisbon side two long symmetrical ramps were developed on the viaduct, now to the side of the Avenida 24 de Julho, more than a kilometer long, now to the side of Almada, where the difference was made by a single ramp with an extension greater than five hundred meters. In concrete terms, according to Peña Boeuf, the bridge would have an extension of 2,232m that added to the viaducts on the right and left sides of the river would take the designed work to a length of 3,905m. In the context of the time, due to the impacts of the proposal, it was the object of strong criticism, since it substantially altered the relationship of that area of Lisbon with the Tagus, being considered by Alfredo Nascimento “an authentic showcase that fortunately did not pass on paper." In addition to the natural opposition of the Port of Lisbon, this solution would already interfere with its territoriality; interestingly, the strategic value of that area associated with shipbuilding and port movements of goods were relevant in the functional freezing of a large part of the right bank of the Tagus next to the city, conditioning its use by the olisiponenses.

In Peña Boeuf’s proposal, according to him, one of the biggest obstacles to solve was the construction of foundations in the deepest parts, since with the technology available at the time it was impossible for a human being to be able to resist the pressures. In order to abbreviate this problem, Peña Boeuf proposed the implementation of a metallic box hollow inside in a cylindrical shape, with a bottom that would be partially covered with concrete, ensuring navigability to move it to the appropriate place. Afterwards, after properly positioned in the boxes that would be between six to seven meters high, the workers would make a perimeter reinforced concrete layer and four transversal adjustment partitions – which would be used to directly support the arches – at the same time that they would help to accurately control the sinking of that apparatus and ensure that all work is carried out dry. This methodology was coincident in its principles with the one that was later adopted at Ponte 25 de Abril. Regarding this solution, Boeuf studied other alternatives, such as a cantilever solution and suspension bridge, but considering the proximity of the costs of implementation and evaluating the values and periodicity of maintenance of the solution, this engineer considered the reinforced concrete solution as the most economical.

In 1927, Boeuf presented a new proposal, with an extension of 2,242m, linking Lisbon to Almada, associating a Spanish financial group that would not impose any charge on the part of the Portuguese state. Despite the positive expectations given that the economic viability of the project is assured, the Society of Portuguese Architects, nevertheless, gave a negative opinion to the project because it “does not satisfy the aesthetic and architectural feeling that a city like Lisbon imposes”, making the opening proposal of a public contest between architects and engineers. Later, in 1951, the same Boeuf, taking advantage of the potential linked to steel constructions and within the dominant world logic, presented another proposal for a suspension bridge connecting Alto de Santa Catarina to Almada.

\[\text{Source: }\text{Boeuf, Alfonso Peña, Discursos y Conferencias, Madrid, 1945, p. 19.}\]

\[\text{Source: }\text{Boeuf, Alfonso Peña, Discursos y Conferencias, p. 30.}\]
For him, the crossing of the Tagus was a subject that motivated him, but that also wore him deeply, since in May 1958, at the National Institute of Prevision in Madrid, in the context of the presentation of his project for a bridge to the Strait of Gibraltar, stated that it is possible to increase a single-span bridge in Lisbon with values in the order of 2,000m in length.\(^8\)

Faced with the alternatives of crossing the Tagus by bridge or tunnel, the newspaper ABC of Lisbon, in 1923, collected opinions from technicians who converged on the best option, showing a biased position on the subject. The tunnel hypothesis was defended through statements by engineer Roldan y Pego, by Cordeiro e Sousa (secretary of the Minister of Commerce) and by municipal engineer António Emídio Abrantes. In addition to aesthetic issues, of port operation, the argument for better behavior in case of bombing in wartime was presented, exposing Cordeiro de Sousa, as an example, an existing tunnel in Liverpool and that in this case, even having a river with smaller width, it was decided to cross the subsoil.\(^9\) In the present situation, the Mersey Railway Tunnel, completed in 1886, which would allow the connection between Liverpool and Birkenhead, would probably be appropriate, since the other crossings have construction dates much later than the year of publication of the article.\(^10\)

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\(^9\) “Através de Tejo”, ABC newspaper of Lisbon, 1st March 1923.

\(^10\) This tunnel was pedestrian and railway, however, given the pollution from the smoke from the locomotives, the population preferred the use of ferries, leading to the failure of investment.
Over time, some entrepreneurs also appeared, as was the case with engineer António Belo, who in 1929 proposed to explore a train line between Beato and Montijo, for which it was available to build the necessary infrastructure, including the inevitable bridge. This proposal came to give rise to a study commission that leaned towards the location previously advocated by Miguel Pais, suggesting the development of more in-depth geological studies in the possible implantation zone. Accepting this suggestion, the Minister of Commerce and Communications instructed the General Administration of Hydraulic and Electrical Services to coordinate the work, and the company Gruen & Bilfinger was contracted for this purpose.¹⁵

The longer it took to decide, taking into account the proliferation of information and the existence of several hypotheses at stake, it became inevitable that the subject of the bridge or tunnel would not lose force and that a headline or clear mind would appear regularly to give an opinion on the theme of the crossing of the Tagus. In addition, the current political regime did not yet have the stability and the necessary power to tackle an undertaking of that magnitude.

Knowing that the hypothesis of implementing a large tunnel to cross the English Channel, connecting France to England, was a hot topic, coming from the previous century, it was not surprising that in 1930 the

In the following year of 1927, in the same year that JAE (Junta Autónoma de Estradas) was created, engineer Fernando de Sousa, as a rapporteur member of the Commission for the Review of the General Plan of the Railway Network, proposed that from Grilos be made a direct mixed crossing to the Montijo spike and from there the knee cap was made with the lines of East and South.¹⁴

¹³ Santos, Sérgio Pimenta, A travessa do Tejo em Lisboa: Passado, Presente e Futuro, p. 82.
¹⁴ Sousa, José Fernandes de, “A Ponte sobre o Tejo”, Gazeta dos Caminhos de Ferro, number 1111, 1st April 1934, p. 177.
¹⁵ “Um pouco da história” in A Ponte Salazar, p. 16.
newspaper “Novidades” put the theme of implementing a tunnel in the Tagus as a subject in evidence. It is reported that Ismael Freire Mergulhão Bandeira Cabral had submitted an application to the Minister of Commerce for the construction and operation of a tunnel linking Rossio to Cacilhas. This intention presupposed that the profile of the referred tunnel was wide enough for two sidewalks for pedestrians and that in the central part there was a wide path for electric cars and carts.16

In practice, what was being engineered was a multipurpose solution that would work for three shifts: one from 6 am until 2 pm for two-way vehicles; a following period for passenger trains; and a third after the closure of the station dedicated to the transit of goods.17

In 1933, the Minister of Public Works, Duarte Pacheco, appointed a commission chaired by engineer João Alexandre Lopes Galvão, in order to, according to this ruler, define the characteristics of this important work of art which should establish communications between the two banks of the Tagus18, call for the competition for the design, construction and concession of a bridge between Beato and Montijo, with a layout similar to that proposed by Miguel Pais, with no apparent success but which had the consequence of implementing another bridge, but only in Vila Franca de Xira. In the specifications for this competition, no previous study was submitted, but it was stated that the bridge should have two valences of highway (minimum 12m wide) and double railroad, with sidewalks of at least 2m, and allowing the boards, functionally distinct, to be juxtaposed or overAPPED.19 Although the tender was carried out in 1934, it did not develop at all because the three proposals submitted, according to the government, did not respond adequately to the terms of the specifications regarding the concession regime, leading to its cancellation in 1935, although the interest of at least the competing company United States Steel Products Company was manifested until 1936. In addition to the problem of comparing proposals, the biggest setback was the very high costs foreseen for

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18 Extracted quote from Costa, Sandra Vaz, O Palácio da Régua e Esquadão, p. 196.
19 Sousa, José Fernando de, “A Ponte sobre o Tejo”, p. 178.
the work. Not assuming the matter closed, in 1938, the American company sent a new proposal, revising the value of the work downwards, but even so, with some changes to the project, the matter did not deserve acceptance by the government, namely by Duarte Pacheco, holder of the Public Works portfolio.20

Still in 1934, engineer Barbosa Carmona, developed a project between Lisbon and the other bank, where a railroad bridge connecting Beato to Montijo was presented, but the crisis that was already being felt did not help to attract technical companies and the necessary foreign financial resources for the enterprise.21 This solution had the virtuosity of enabling the connection with the existing railway from the Ramal do Montijo, ensuring a purpose that was beginning to be urgent of the existence of a structuring railway line connecting the north to the south.

It is evident that the development of the south bank of the Tagus, due mainly to the lower costs of the available land, has made this area desirable despite the insufficiencies in terms of circulation to the big city. Afonso Zuzarte de Mendonça, in 1938, prepared the study of a railroad bridge, suspended, in the corridor between Belém and Almada.22 This author gathered solid arguments about the weaknesses of the location that connected Beato to Montijo and used the strength of the recent construction of the Golden Gate bridge as a constructed example that in the distance between banks was very similar to that between Belém-Almada. What the author had in mind was the use of the narrowest part of the river, defining a location on the right bank between Santos and Bom Sucesso and on the left bank between Cacilhas and Lazareto. In parallel, it was proposed to develop an urban study for the south bank next to the river and from the right bank to the west of the Alcântara riverside. Afonso Zuzarte’s exposure highlighted the possibility of height of the board, without obstructing navigation; the implementation of a minimum number of pillars in the water, minimizing obstacles; less difficulty in removing wreckage in the event of a bridge collapse given the nature of the structural solution being predominantly metallic; and the aesthetic issue derived from the elegance and grandeur of the work, functioning as a majestic maritime entrance to Lisbon.23 But Europe was now experiencing moments of great tension, totalitarian regimes dominated most states and very soon – in September of the following year – Nazi Germany would invade Poland, giving a strong reason for the beginning of the Second World War.

In this long period, several proposals were pointed out or developed, but if anything managed to unify them, it was the fact that almost all of them provide for the intensive use of metallic solutions. Anyway, through all the synergies in conflict, it was evident the existence of political and social pressure to build a bridge from Lisbon, although there was always something that prevented this purpose from being able to transfer from paper to reality.24

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20 "Um pouco de história," in A Ponte Salazar, p. 16. See also de Costa, Sandra Vaz, O País a Régua e Espaçado, p. 198 and also Santos, Silvio Pompeu. A travessa do Tejo em Lisboa: Passado, Presente e Futuro, p. 54.
21 Journal O Século, 6 August 1936, p. 5.