

# The Effects of Concrete on Portuguese Architecture: the Moreira de Sá and the Malevez Case (1906-1914)

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## NINE WOMEN WORKING ON CONCRETE

Nine sturdy-looking women with solemn, concentrated expressions on their faces appear in a photograph published in 1911 in a magazine called *Le Béton Armée*. The article was about the early triumphs of Hennebique's reinforced concrete in construction work in Portugal and refers in passing to a rare and strange fact in the company's history: women were being employed as construction workers. The original photograph in the magazine's archives shows that six of these women are barefoot and that there is a group of men in the background.

This singular event is obviously of interest to Portugal's social and labour historians, but it also challenges architects to ask themselves questions about a number of issues that represent a key to understanding their profession. If reinforced concrete probably influenced the way work was organised in that women were brought into construction work, then surely these changes would have altered the conditions of and demands on the design process? To what extent did transforming the building process affect the way architects designed? And did this not mean that as a result the mechanism of design and the architectural conception were also transformed?



Figure 1. Concrete workers on the Luiz Bandeira Bridge over the Vouga, 1909 (IFA/CAA).

In the first years after reinforced concrete had been invented and was in use as a building material in the second half of the nineteenth century, intuition and experiment played a decisive role in discovering how concrete behaved and in getting public recognition for its strengths and virtues. With the stabilisation of calculation methods and standardisation of construction procedures, reinforced concrete was gradually used on a regular basis. In the early twentieth century, reinforced concrete required a mastery of abstract theory and a method of understanding that led to a system in which the conception of a structural project was basically not visual but mostly speculative according to a model of relationship of forms and distribution of strengths.

If we focus on design, understood here as a sequence of actions leading to an architectural plan and consequently the realisation of the work, we notice that since its early beginnings, reinforced concrete sparked all kinds of controversy, hesitations and enthusiasms at various decision-making levels. These conflicts influenced the work of architects with a force that in our view was already in existence before reinforced concrete was used as an argument to explain an epistemological rupture in their work.

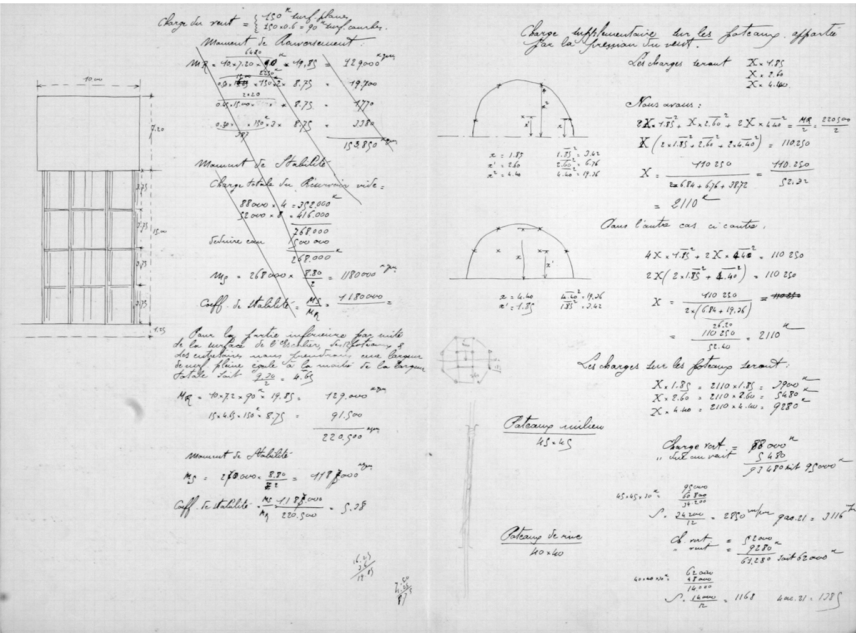


Figure 2. Reservoir in Barreiro, calculation draft, 1907 (IFA/CAA).

Reinforced concrete was thus used as a rhetorical device in the battle between conservative and avant-garde architects, in particular in the European quarrel between the “modern/non-modern” instigated by committed architects and historians such as Sigfried Giedion (1888-1968). This fact has already been the object of some historical reframings (Legault 1993). In that discussion several

avenues of questioning the original character of the use of reinforced concrete in modern Portuguese “pioneering” works were opened by the reconstitution of methodologies and processes of establishing the product commercially that François Hennebique (1842-1921) had carried out in an international context (Delhumeau 1999).

Reinforced concrete did not renew eclectic architecture as much as make it more viable, and acted as a measure of preservation and not as a process of rupture (Gubler 1982). In fact, all that Hennebique did, insofar as project managers were concerned (particularly well recorded in the work of his agent in Turin), was to mark with a red pencil the necessary structural points over blueprints thereby confirming the spatial design suggested by architects and designers (Nelva, Signorelli 1990). However, these operations do not conceal the progressive change in the circumstances and tasks involved in organising and managing design.

At the end of the nineteenth century, Jacques Monet and M. S. Reynaud & Co., respectively François Hennebique’s and Paul Cottancin’s (1865-1928) agents in Portugal, were responsible for a number of civil constructions that might be said to have pioneered this building method in Portugal (Ferreira 1989). However, they were exceptions and appear not to have influenced existing building practices. Things rapidly developed in the early twentieth century with increasing confidence and understanding of the building material and the licensing of patents to more enterprising firms.

Certain activities carried out by Moreira de Sá & Malevez (MS&M) are recorded in documents found in the Hennebique company archives, and thanks to these documents we have discovered a way to approach and understand the issues we think interesting. The aim of this presentation is to show how the new system introduced a distribution of tasks that, according to our notion, led to the establishment of new planning practices. From the moment the company was set up in Portugal, it is possible to determine not only the peculiar ways reinforced concrete became an established building practice, but also the enthusiasm and conviction with which architects and engineers recommended it (as a product), gained specific knowledge as to its uses and properties (as a method) and came up with blends that pointed to new ways of employing the actual tools of the trade (as a conception). These processes came prior to the afore-mentioned “epistemological rupture” and allow us to see the conscious assimilation on the part of Portuguese architects of new planning strategies that resulted from reinforced concrete.

With work records going back to 1902 and a technical office in Lisbon since 1906, the volume of work they were involved in increased until 1910. It seems that the implantation of the Republic on 5 October 1910 (and the subsequent dismantling of State and investment structures) was the cause of the first slump in business. In March 1913, on encountering difficulties in building pile foundations for a metal bridge, the Portuguese agent once again contacted Hennebique and later went on to build a few important works (bridge foundations and deck, warehouses). This second cycle was interrupted at the end of 1914.



Figure 3. Reservoir in Lisbon, 1907 (IFA/CAA).

MS&M viewed with equanimity the small scale of their commissioned work. After all, they were just agents working without great ambition in a territory where there was no general agent to play the essential role, within the Hennebique hierarchy, of promoting the product and managing the work in each country. This meant that the agent had to jump over the usual hierarchical order and contact Hennebique directly, which led to some misunderstandings and the tenuous implantation of this building material in Portugal. Their first work was carried out independently but, after the two agencies in Oporto and Lisbon had come together, into a bicephalous technical office. The files of correspondence originate from Lisbon and a reference to a wrongly addressed letter on 17 April 1902 leads us to believe that each of the two offices was in fact independent: “To this end, we once again request you to address yourself always to Lisbon for everything our Lisbon office asks you and to Oporto for whatever our Oporto office deals with directly” (076-Ifa 33 776, 17 April 1907). The

company in Oporto was represented by the Brussels-trained engineer, Bernardo Moreira de Sá (1879-1919), the eldest son of Bernardo Moreira de Sá (1853-1924), a conductor and musicologist who had set up an important music circle in Oporto. Very little is known about Malevez, his Lisbon partner, except that he was most probably Belgian.

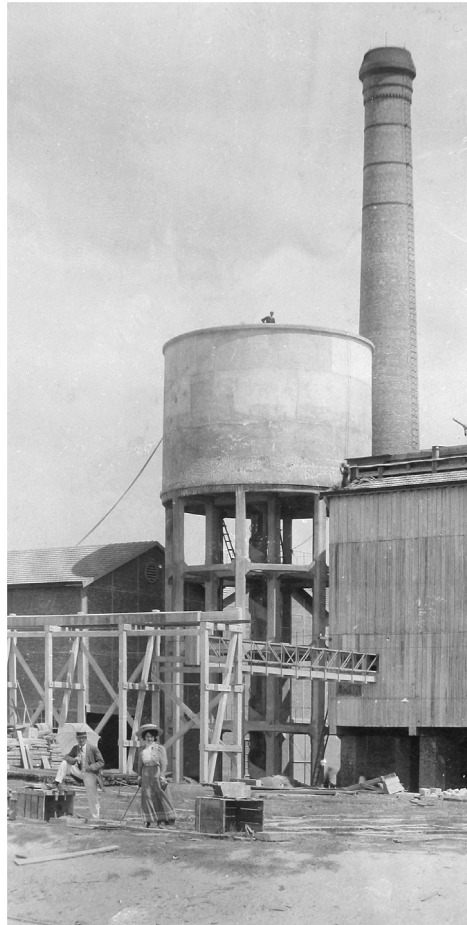


Figure 4. Reservoir in Barreiro, 1907 (IFA/CAA)

## A CONCRETE CONSTELLATION

After the first licence to use the Hennebique patent expired in Portugal, MS&M, in competition with Pierre Teissier, tried to introduce reinforced concrete construction in an organized fashion.

If the lack of information prevents us from having an exact list of Hennebique's works in Portugal, the list published monthly in the magazine *Le Béton Armée* mentions about 160 mainly small-scale

projects. Based on this information, we can arrange a new list by different criteria, either chronological, typological or the geographic position of the works and shows clearly their distribution throughout the country and the connection between this distribution and the concentration of the commissions.

A feature to bear in mind is the objectified nature of the works. The choice of reinforced concrete seems to belong to the promoter and is a precise order: “I want a reservoir!” The agent plays the part of the supplier of certain material and not that of the architect. The order is not a conception that solves a problem with several variables and does not require mediation of the project.

Road network (or its absence) and above all railway network (the railway was one of the agent’s main clients) are two keys to explain why the works were located in areas that were of easy and also of very difficult access. There were also small commissions in rural or balneary areas (wine producers, spas), which suggest the importance of work commissioned by old rural noblemen’s estates connected to the urban bourgeois of Lisbon and Oporto.

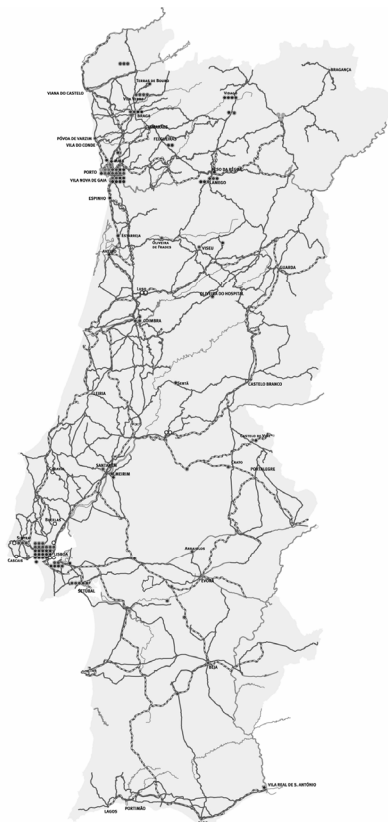


Figure 5. Distribution of commissions and projects by Moreira de Sá & Malevez.

This was a different way of working than the one introduced by the metal constructions of railway networks. The agent himself explained his view of the works in the area:

From the top of the reservoir [...] we have a truly superb panorama for the reservoir is 17 metres high and located on the highest point of town [...] so on a fine day one can see the reservoir [in Barreiro] which is in distance [...]. What a wonderful place for a wireless telegraph!

(Moreira de Sá & Malevez, 1910)

This vision reflected a way of linking different places by means of commercially related networks that were not necessarily dependent on transport systems. The possibility of building with sand and local labour, including women, together with a little cement and iron that could be relatively easily transported allows us to bring together what had initially seemed separate locations.

Along with the manner in which commissioned work was assigned while taking into account the geographic distribution of the construction work in Portugal, there were new circumstances, especially with regard to the workers' qualifications. The first reinforced concrete manual published in Portugal carefully described precautions to be taken when doing the work. With regard to the work tasks, special reference was made to the construction foreman, who had to understand the engineer's plans and speak with him, and also have sufficient skills as a carpenter, blacksmith and mason to be able to give orders to workers and check that the different element of the work were executed properly.

The workers do not have to be skilled, though this is preferable. [...] if the construction foreman is properly trained as already mentioned, the carpenter does not have to be a first class carpenter as his work is virtually just sawing and nailing, and he uses an adze far more frequently than a planer. Good workers with a competent carpenter under a foreman's instructions can make all the mouldings. The same applies to the ironsmith [...] as all he is required to do is bend, cut, brace, etc., in iron bars or rods, besides knowing how to sharpen and adjust tools, etc. A mason is also unnecessary as making concrete only requires workers who can mix cement.

(Segurado [1918], pp. 561-2)

As a result, this "new technology" seemed very accessible to local people and the materials easy and practical, which allowed its use to spread rapidly to the poorer regions of the country. On the other hand, training in conceptual planning had to develop and this delayed the whole process of disseminating the system.

## **THE HYPERSTATICS OF DESIGN**

The introduction of reinforced concrete into Portugal brings us to a practice that simultaneously involves architects and engineers who design the projects, builders and foremen who control

networks and have the necessary skills to run the building site, the government that regulates and demands procedures to ensure safety, developers and promoters intent on economising the costs and public opinion that shows their interest in novelty. They all operate within a framework of commercial competition that carefully blends the variables that guide the project's options. While Hennebique focussed on the monolithic character of reinforced concrete, its actual execution consisted of a complex combination of features.

For MS&M this meant "selling the know-how" made available by Hennebique and providing technical guarantees as "consultants". For years and depending on the type of order, the role of Paris and Lisbon in the choice of solutions varied without ever questioning Lisbon responsibility for the performance, durability and quality of the work. The relationship between MS&M and the Paris technical office is not clear and the gap in the hierarchical order created more misunderstandings than a healthy relationship of shared information. Apart from news items and complaints about delays in dispatching sketches and technical data, letters between Lisbon and Paris focussed on many *quid pro quo* issues and a sense of mutual distrust. It was either suspicions about the set price of the work (generally considered too low) on which Hennebique's fees were calculated, or then distrust arising from abusive use of the sketches and technical solutions seeing that it seems to have been impossible to control the agent's activities closely. In this dispute and when threatened by possible internal competition sparked by Hennebique, MS&M were not afraid to tell Paris about their "value as general agents for Portugal" that ensured them rights over contracts that other firms made using Hennebique patents in the country (076-Ifa 36 405, 15 October 1907).

Model and general construction options were usually selected in the Lisbon office, which drew up a scheme of choices and structures based on an already known formal model. This preliminary work was followed by consultations with Paris, requests for opinions and, when necessary, adopting suggestions for more efficient alternatives. This sequence of events developed into requests for Paris to send construction plans and finally into demands for building contracts and comprehensive lists of materials. In addition to these increasing demands and options, there later appeared "state engineers" who intervened in public works and complicated matters with their demands. Fine-tuning the work and an "OK" from Paris were essential in order for them to accept responsibility for the work. Apparently, MS&M did not have complete mastery over performing the necessary calculations and would not risk large construction work without the support of the guarantee of experience. On the other hand, this experience was also required by state engineers in charge of the commissioned work. For small private works, as well as for comparable or repetitive work, the same procedure did not have to be strictly followed and the plans were not even sent to Paris for approval.

If consultations with Paris were an argument for debating solutions, precision in preparation for the project was also essential in order to achieve levels of detail and predictability that allowed competitive budgets to be presented when tenders were invited. Correct information became



decisive in the competitive race. It is understandable that there was a direct relation between having technical know-how and the competitiveness of the method seeing that control over the building costs depends on the depth of detailed knowledge as to the necessary quantities of material and manual labour. Apart from the technical seal guaranteed by the name Hennebique, methods for calculation that resulted in economical amounts of materials being used was particularly interesting to the agent. Without this information, of which they were either unaware or else did not master properly, they were in no position to declare themselves reinforced concrete constructors in that they were in no position to assert that they were reinforced concrete constructors in a commercial sense.

Before MS&M appeared on the scene, reinforced concrete had already been authorised in civil construction at academic and corporate levels as well as officially permitted by the government. The second Hennebique agent did not have to check out the technique, perform experiments or certify the method. However, they invested in publicity and they had to do this to make the product appealing to the higher cadres at the Ministry of Public Works as well as attract other engineers and public opinion in general. Despite their efforts, they told Hennebique when referring to state engineers that “there will obviously be a great deal to say about fear as well as a certain lack of practice that dictates these gentlemen” (076-Ifa 57 854, 16 July 1913). A large number of articles published by Portuguese engineers in engineering magazines around 1908 or else in 1913, as well as the publication of the first Portuguese regulations on the use of reinforced concrete and a specific manual around 1918 lead us to believe that public knowledge about methods of reinforced concrete construction was being widely consolidated in Portugal at this time. These kind of complaints coming from MS&M should be understood as their problem in relating to other building agents rather than an expression of their outstanding mastery over some special knowledge.

To return to 1906 and the setting up of a technical office in Lisbon, we can see that if it was MS&M who chose the initial concept, it was state-employed engineers who worked on revising the project and setting up its basic requirements. In discussing solutions for the bridge over the Vouga River at Oliveira de Frades, Malevez favoured increasing the concrete section and decreasing the reinforcement bar size in order to balance the shear forces, which went against the opinion of the state engineers who insisted on increasing the rebar element. The difference of opinion in the composition of reinforced concrete ensued from manuals the engineers consulted, in particular that of Paul Cristophe and they referred to his recommended methods (076-Ifa 28 351, 23 September 1906). To defend their position, MS&M appealed to Hennebique or else adopted the ploy of presenting incomprehensible calculations that baffled the reader:

The calculations for the arches may appear incomplete to you, the reason being that the state-employed engineers have made so many demands that we are forced to make them see or believe that we are doing what they want.

(076-Ifa 28 351, 23 September 1906)

In any case, MS&M were obliged to adopt the state engineers' instructions seeing that they were in charge of the larger commissions. Annoyed by this, the agent made disparaging remarks about engineers who "resemble puppets whose strings are pulled by colleagues in Paris" and that "have decided to apply strictly [...] the basis of the French ministerial circulaire of 20 October 1906". The French circulaire, which promoted methods that Hennebique questioned in his magazine, was also used by several engineers with responsibilities in Portuguese engineering. Faced with this awkward situation, Malevez told Hennebique that "one has to observe the ministerial circulaire scrupulously and absolutely as the *sine qua non* conditions [...] as well as the instructions and report that come with it" (076-Ifa 37 101, 1 January 1908).

Designing without taking into account the demands of the state engineers and the French circulaire meant losing the commissions. This made matters a little complicated at the moment of drawing up the project and exchanging information and opinions. No specific regulation existed in Portugal before 1918 but already by 1908 certain solutions had not been acceptable "unless we can demonstrate that Hennebique has 12kg or more involved in a large work for the French state and that this rate had been accepted" (076-Ifa 37 101, 23 January 1908). To the despair of MS&M, Paris does not take these demands into account, or then only after some insistence, which made the agent ask permission – always with great deference to the technical office and its directives – to work on the design and calculations and produce variants.

## **A VIRILE DEMONSTRATION**

Getting commissioned work was a competitive business. It appears that until 1910 Pierre Teissier was the competitor offering other reinforced concrete systems in Portugal and his projects were drawn up, according to MS&M, by Rouvérol. Competition for commissioned work in the absence of a general agent prompted some rather strange proceedings. Apparently, they only got back to Paris when adjudication was ensured. This fact greatly influenced competitiveness as they were unable to present accurate budgets and had to give themselves very wide margins to be safe. In January 1908, they asked Hennebique to start on a project while running the risk of not being able to pay the "usual" 6%. According to them, their competitors only had to pay a usual 2% for special projects. There was also another high risk at stake seeing that Hennebique took a long time to reply and the tender periods (15 days, 3 weeks) were very short, which meant that the Portuguese agent could lose out on some deals.

On the other hand, Paris had their doubts about the budgets Lisbon presented. When Hennebique received a commission for construction work in Lisbon directly through Dumesnil (an agent in Paris) and Stinville (an engineer in Paris), a number of almost comic episodes followed. Hennebique asked the Portuguese agent for information about the type of terrain at the work site and asked him to keep the matter confidential. With this information he determined a price and presented it to the promoter in Lisbon. It was one of the rare occasions in which Paris established a

price and it apparently astonished the client who thought it was exorbitant. MS&M, who must have realised what had happened, were later involved in a portion of the construction work, just as Hennebique had initially projected it but for a considerably lower price. This is the only known case in which the commission came via the Paris office. For all other work the agent made a bid for the tender or managed to convince the client of the system's performance. This naturally influenced the "choices" of projects seeing that a concept in which there was a more equally balanced distribution of stresses could easily be put aside for the sake of another that was cheaper and, from a certain standpoint, more competitive.

If divergences in how the calculations should be made went towards consolidating exchanges and conflicts of interest, examples of completed constructions were presented to the state engineers as a way of promoting the building method. Although MS&M were not working actively as general agents, they did recommend to potential clients examples that came from Paris, chimneys made in Buenos Aires, Hennebique brochures presented at international exhibitions, etc. These examples appealed to people and Lisbon needed Hennebique's cooperation in order to meet the demand. However, as we have seen, their working together was not very effective. In a letter requesting Paris to stop their custom of not making the plans for the work available before the commission, MS&M reveal the necessary procedure to obtain a contract:

You should remember that we asked you some time ago to give us some examples of bowstring bridges built in reinforced concrete; you sent us back blueprints that we showed the railway engineers. These gentlemen are firmly decided to get this solution accepted by the board and if you help us, we will certainly be favoured: a tender would be invited which would allow reinforced concrete to be used but we have to present ourselves, not only with a project in as much detail as if it was about to be built, but also we need to give examples of the most important railway bridges using this method as well as any photograph you can get [...] I will send you all the information straightaway and the tender will be open some days afterwards with a very short delay so that our competitors cannot take the business away from us (confidential).

(076-Ifa 57 854, 16 July 1913)

The costs were undoubtedly the prime concern in making a choice. However, Lisbon cathedral tower shows another two vital considerations to be taken into account: the lightness of the material and its plasticity that allowed "stone masonry" to be copied in all its "dignity". The tower had started to lean to one side as a result of the 1755 earthquake and repairing it only became possible thanks to these two properties. The virtues of the quality of the material is sung in an article published in 1910 and it was mostly its capacity to resist floods and earthquakes rather than fires that MS&M emphasised when promoting the system. On the other hand, as they were not general agents, it was up to the agent to choose the type of construction for the commission and reinforced concrete was not always the most suitable. The Alcáçovas dam is an example that clearly reveals

the subtle difference seeing that reinforced concrete was the more expensive solution. Although they presented different construction solutions, the agent did not hesitate to adopt a mixed solution in stone. Reinforced concrete was an example among other alternatives and its presentation was shown to be useful two years later when the height of the dam was raised.

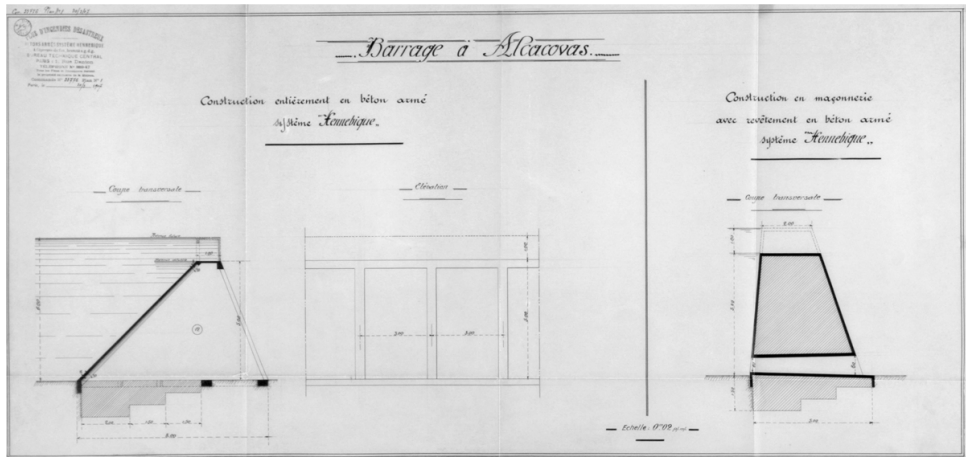


Figure 6. Alcáçovas dam, alternative solutions, (IFA/CAA).

There was a certain sporting aspect in outdoing competitors and consisted of exploiting the “new” and “daring” qualities of reinforced concrete. It was its “virility” that gave it quality and it could innovate and overcome any obstacle. However, the agent had to “win” a respectable place in the world of construction slowly and calmly without too aggressive publicity. If the agent on a number of occasions failed to make every effort to build in reinforced concrete, on other occasions he believed it necessary to “win over” the opposition and “silence” their “foes”. An example of this is a small tunnel that was commissioned to make up for a contract that was later cancelled to build a bridge in Setubal. MS&M had turned down an offer of compensation and insisted on another commission as an alternative. When they got it, they informed Paris that “this time we have managed to defeat political influences that have done us so much damage on several occasions!” (076-Ifa 31 458, 13 March 1907)

It is not exactly clear who these “foes” were: whether they were builders using other methods and materials, or other reinforced concrete builders and competitors or just critics of the aesthetics of the new material. Whoever they might have been, MS&M wanted to make a statement and the completion of the bridge over the Rio Vouga in Oliveira de Frades was the ideal moment to do so. A demonstration of reinforced concrete was to be staged like a public spectacle.

It is our intention to invite to the essays the chief engineers of Portugal with the general director of Public Works at their head [...] We wished the display of trials and tests would

convince the engineers of how good the system is but without exceeding sensible limits in order not to cause unnecessary wear and tear to the work in which we in fact have the greatest of confidence.

(076-Ifa 28 351, 20 September 1907)

The four separate stages of this display began with the classic test of an even overload of sand, then filling the bridge with carriages, measuring the distortions at the opposite ends as one carriage went from one side to the other, and as a grand finale, a performance with fifty male gymnasts in order to check the bridge's vibrations. Paris had to dampen the agent's enthusiasm and advise them to be careful about the gymnasts:

It is also a good idea when engaging in operations of this kind, to which no railway bridge can be subjected, to be very careful and start off with three or four men while constantly increasing the number while following the movements of the bridge.

(076-Ifa 28 351, 23 September 1907)

The Portuguese agent, who was usually very cool and collected in business dealings and prudent in technical matters, showed daring and pride when it came to concrete and its apparent virility and seemingly wanted comparisons to be made with the strength of the athletes who were to parade across the bridge. He described in a heroic style how a reservoir of water built in Lisbon had survived a violent storm:

On the day of the storm [...] we were curious so we went up there to have a look and despite the lightness of its appearance, its slender legs, the distance between trusses so economically arranged, despite the force of wind on its top half, the reservoir, which looked like a child's toy, held itself upright, genuinely more upright than a senator, which just goes to show that slender legs are sometimes more solid than thick ones. We do not know if you find the reservoir beautiful; we ourselves are very satisfied with it.

(Moreira de Sá & Malevez 1910)

## **EMOTIONAL DESIGN**

Reinforced concrete is a paradoxical combination of an abstract practice involved in producing an extremely sensitive material. Paris was afraid that it was too early to take away the shattering of the Oliveira de Frades bridge, and explained to their agent the difficulty of keeping to precise criteria to assess the conditions according to which the different materials involved would become a composite one. The quality of cement, weather conditions, climate and local levels of humidity are part of the information that can only be obtained in loco. To check the tension they had to "sound the concrete with a hammer to find out how set the concrete is" (076-Ifa 28 351, 23 September 1907). This intuitive way of gathering information differs very little from plain commonsense and remained an additional way of checking the calculations.

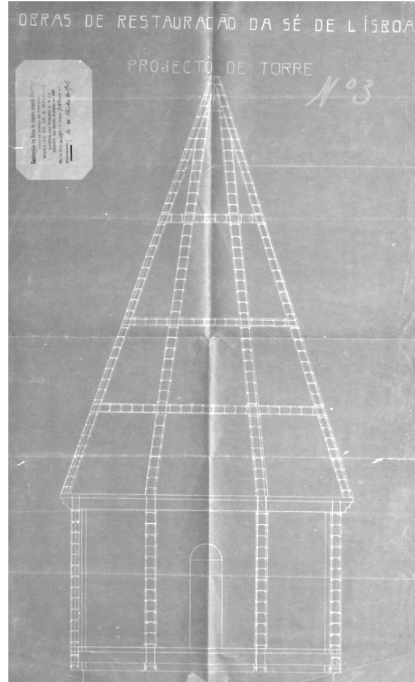


Figure 7. Lisbon cathedral tower, work sketch drawn in Lisbon, 1907. (IFA/CAA).

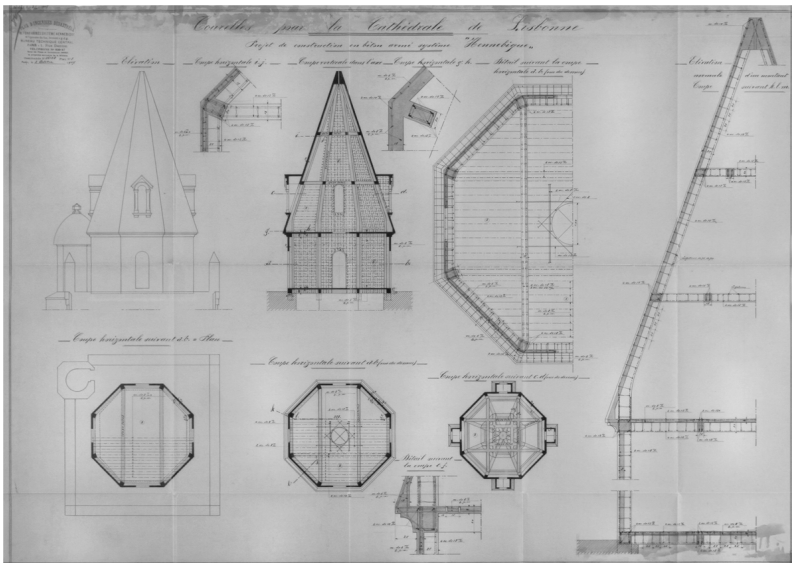


Figure 8. Lisbon cathedral tower, construction plan drawn in Paris, 1907 (IFA/CAA).

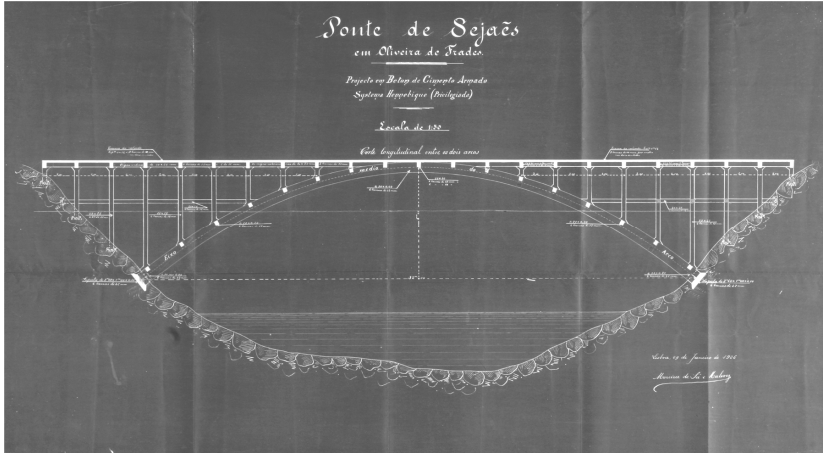


Figure 9. Oliveira de Frades bridge over the River Vouga, basic plan, 1906. (IFA/CAA)



Figure 10. Oliveira de Frades bridge over the Vouga, shuttering, 1906. (IFA/CAA)

We have seen that MS&M did not hesitate to obfuscate their calculation methods as a ploy to dupe the “authorities”. However, what is amazing is that there were no “execution plans” for some of the works. In the case of the bridge in Oliveira de Frades, the Hennebique archives only have a general sketch of a longitudinal section which describes basic work data but without any detail on reinforcement. Paris wrote some remarks on it which were afterwards transcribed in a letter to Lisbon. Lisbon wrote back: “As for the examples of our construction plans for the Oliveira de

Frades bridge, we only made some rough sketches in our notebooks, but if you like, we can bring them together and send them to you” (076-Ifa 28 351, 12 October 1906). This sounds as if the work was what used to be known as a “*projecto de bengala*”, a Portuguese expression that means that the architect or constructor explains his ideas so exactly on the work site with the aide of a walking stick that he can follow the construction work carefully and personally without providing any plans or drawings.

Maybe because of the difficulties experienced when the work was being carried out, or maybe because of the lack of safety measures in the building site, Paris had been making very detailed execution plans since 1907 for building works being carried out in Portugal.



Figure 11. Oliveira de Frades bridge over the Vouga, 2005.

## DESIGN STRATEGIES

If we understand design as a sequence of actions that leads to control over the plan and thus to the dimensioning and construction of the work, we can observe that these hesitations, enthusiasms and conflicts so evident on the part of MS&M played a decisive role in establishing new ways to draw up plans that the reinforced concrete way ended up imposing. This applied both at the moment of drawing the construction plans, and mostly at the moment of drawing up the equations that led to these plans. Without going into the innovative or new features of certain processes, it is understandable when observing the period in which reinforced concrete was introduced into Portugal, that the people involved in the drawing up the plans, be they engineers, owners or



constructors of the works, had to henceforth take into account a number of decisive factors for the “quality” of the work. Architects, as well as everyone else involved in the constructive process, had to subject their work methods to this new system:

- \* Commercial networks for the material (publicity, influences, etc.) and access to commissions: reinforced concrete appeared to suffer little from remoteness to large transport infrastructures and was sufficiently adaptable with regard to the localisation of decision-making centres.
- \* Potential to organise companies insofar as there was no dependence on corporative manual labour, and non-skilled and very badly paid labour could be exploited. At the same time, a strong specialisation in planning is noticeable.
- \* Low prices and the ease with which it could implant itself in the terrain offered competitiveness that could find solutions and build objects with new technical means.
- \* Structural requirements, the various methods of calculations and how they related to regulations meant processes of organisation that needed smooth links between the various entities involved in producing designs.
- \* The growing importance of the abstract plan before the work itself increased dependence of the building site with regard to the predictability of the design. Although it retained a somewhat intuitive facet, work execution becomes more of an analytical *a posteriori* rather than synthesis.
- \* Experience and non-innovation, or atavism in certain design choices, are part of the quality guarantee that oscillates between international diffusion of models and the hereditary nature of habits.

What could become plausible is the diffuse and commutative role of the actors and the production conditions, technical knowledge, political and commercial interests, rapid adaptability to the terrain and, in the end and above all else, the emotional and unconscious cultural involvement in setting up a planning practice that diverges by its abstract nature from one that was inherited by building processes that came before reinforced concrete (stone, wood, metal, etc.).

In this research into the case of Hennebique’s agent MS&M, we have seen that this “slippage” is very evident in the Portuguese context in the period leading up to the First World War. The architects had to deal with this transformation in the conceptual processes and if from a formal point of view their architecture managed to withstand it in appearance, the processes of concept transformed it in essence.



Figure 12. Fábrica do Caramujo, Jacques Monet, first Hennebique agent in Lisbon, 1896 (IFA/CAA).

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