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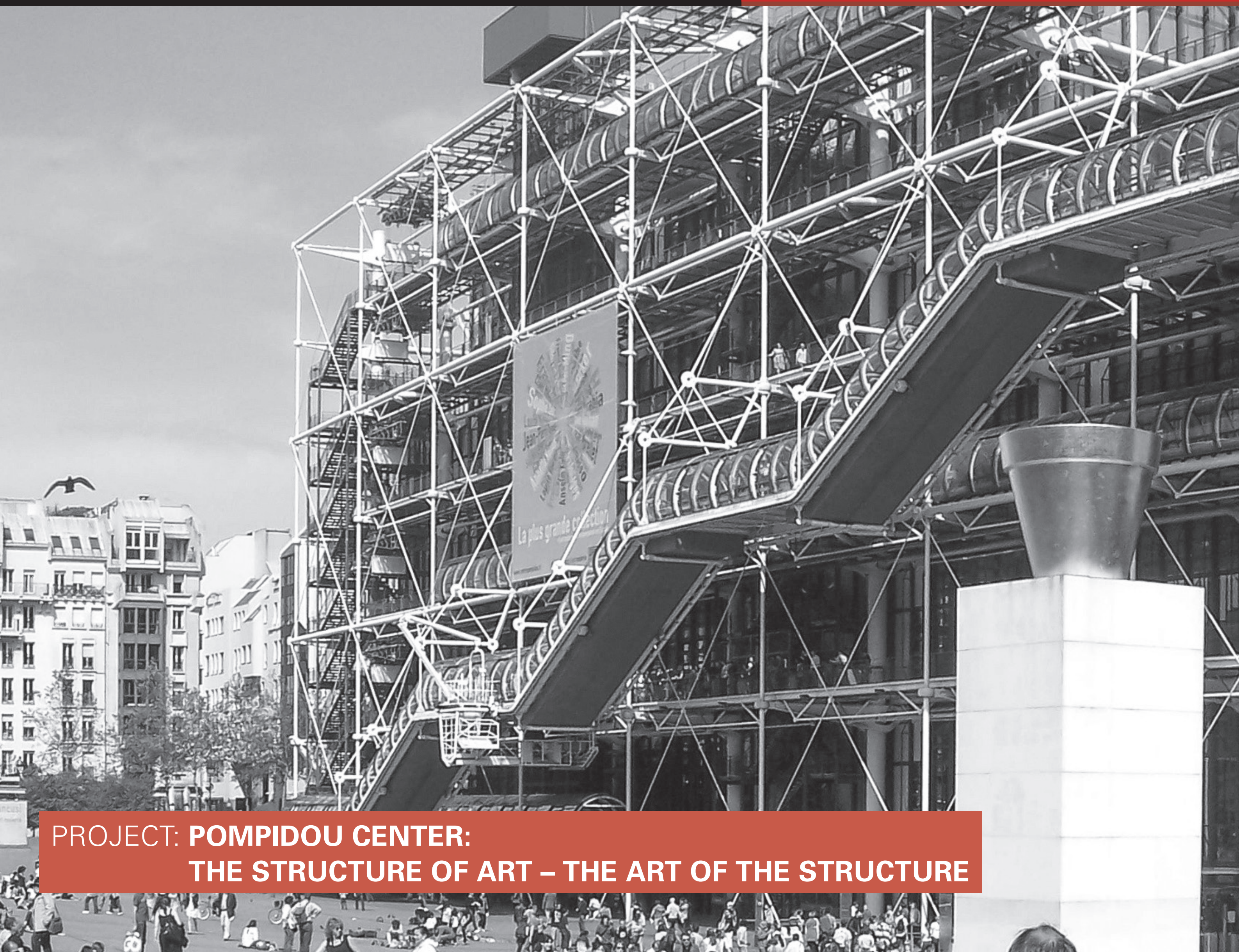

PROJECT: **POMPIDOU CENTER: THE STRUCTURE OF ART – THE ART OF THE STRUCTURE**

XI CONFERENCE ON STEEL AND COMPOSITE CONSTRUCTION

SPECIAL THEME

THE NEW GENERATION OF EUROCODES

23 and 24 NOVEMBER 2017

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ASSOCIAÇÃO PORTUGUESA DE CONSTRUÇÃO METÁLICA E MISTA

Nuno Lopes
Director

One of the greatest names on Portuguese engineering is no longer among us. Professor Mota Freitas, CMM's honorary member, has marked several generations of engineers by his dedication to civil engineering education and by the impressive projects he left us. For these reasons CMM pays him tribute in this edition of Metalica.

Following one of Metalica's previous articles of opinion, the project article is dedicated once more to the Pompidou Center building, presenting now with a engineering vision the impact this building had on the use of steel in construction. The challenges and solutions found in the development of this project are discussed here, highlighting the intense collaboration between architecture and engineering. The regular articles of opinion bring us very interesting perspectives and case studies in the different topics covered.

Finally, it is aproaching another edition of the Portuguese Conference on Steel and Composite Construction which is expected to be very interesting to designers, researchers and companies working on this field. As announced here, the conference already has the confirmation of keynote speakers which are internationally recognized in the area of Steel and Composite Construction.

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contents

José Mota Freitas, Engineer and Professor (1938-2017)

“The project for the structures of the Church of Santissima Trindade represents the culmination and recognition of his brilliant career as an Engineer”

Professor Mota Freitas was one of the leading figures in national engineering and has been distinguished with several awards throughout his career. Professor José Mota Freitas, a reference for several generations of professionals, had a career of more than 40 years as a professor at the Faculty of Engineering of the University of Porto (FEUP) and as a highly successful designer.

Graduated from FEUP, teaching was one of the most cultivated facets of his life. As a professor at the Faculty of Engineering, Prof. Mota Freitas taught a wide range of courses in Civil Engineering: Structural Theory, Soil Mechanics, Resistance of Materials, Civil Constructions, Steel Constructions and Steel and Composite Structures, leaving thousands of manuscript pages describing consecrated solutions, International recommendations, or present tables for practical applications.

In the most recent years, he was in charge of courses on Steel Structures and Composite Structures, as well as the orientation of theses in the Master Course in Civil Engineering Structures. He also collaborated in several postgraduate training actions, as well as teaching MSc disciplines at other Universities.

Returned to Porto, after military service, and along with teaching at FEUP, he was part of the ETEC Study Office, of which he was later a partner. In it he worked as a designer – especially in the area of structures – as well as consultant and project coordinator.

As a designer and as a teacher, he excelled in the area of steel structures, giving a great boost to both his study and his practice.

Among the numerous works he has designed in these decades, the following stand out:

91 bridges, pontoons and viaducts, of which 37 are steel or composite. Particularly noteworthy, are the railway bridges of Ferradosa, several bridges along the Cascais line, along the North, West and Beira Baixa lines, such as the Meimoa bridge, the temporary Belém viaducts for Expo 98 and the rehabilitation of the Coura bridge, a difficult work, of great technical and aesthetic interest.

Between buildings, industrial installations, silos, chimneys and diverse structures, there are 152 interventions, 100 of which involve steel structures. Highlighting some examples as “William Graham” and Foco Church buildings, Soporcel paper mills in Figueira and Setúbal, as well as many other manufacturing and related facilities, the Trinity Auto Silo, the Gaiashopping Skylights, various structures interesting from various shopping malls and hypermarkets, being the more “special” the Santa Maria da Feira, the lightening of the roof structures of the Oceanário, several structures for large Electricity Poles and Transport Posts, the steel

Structures of the Sheraton Hotel in Porto, the support structures of the Casa da Música glazing and the works at Fátima, such as the Capelinha das Aparições, Pastoral Center Paulo VI and the Church of Santissima Trindade.

The project for the structures of the Church of Santissima Trindade represents the culmination and recognition of his brilliant career as an Engineer, since he was awarded the Secil Civil Engineering Prize in Portugal in 2007 and in 2009 the Ostra International Prize (Outstanding Structure Award), awarded by the IABSE – International Association for Bridge and Structural Engineering, which is considered the most important award in Structural Engineering worldwide.

Its presence in the list of Scientific Commissions of the most prestigious specialty congresses was recurrent and a recognition. He was part of the Working Groups on Eurocode 3 and 4 of Technical Commission CT115 – Eurocodes Estructural.

His career and interest as an engineer also extended to many vast fields:

– the joint use between reinforced concrete and steel, being a precursor in Portugal of the study of mixed structures;

– pre-effort, having already developed for more than 30 years a process of introduction of equivalent actions in bar structures that is still used, only improved by the systematic processing that the computer came to facilitate;

– Bridges, where he was a pioneer in composite bridges (with and without concrete involvement), in the study of prestressed reinforced concrete bridges made by advances, and his adoption of "lost" encounters generalized;

– buildings, in which he approached in a brilliant and early manner the question of the distribution of horizontal actions by the various resistant elements and the evaluation of the respective deformations, a study that successfully applied to Porto buildings that, at the time and for many years, were the taller;

– foundations, with the approach and systematization of less usual systems, such as embedded wells and others;

– concern about the fire protection of structures, especially steel ones;

CMM pays its last honor to Professor José António Fonseca da Mota Freitas, Honorary Member since 2007, considered one of the greatest names in national engineering, who passed away on last January, at the age of 78.

PROFESSOR MOTA FREITAS – Tribute from his peers

Professor Mota Freitas was a national and international reference of engineering and in particular of the steel and composite construction, practising for more than four decades functions related to this area, either as a professor at the University of Porto or as an engineer in the ETEC office. There were numerous projects in which he participated, including the structural project of the Church of Santissima Trindade, with which he was awarded the Secil Civil Engineering Award in 2007 and with the Outstanding Structure Award, awarded by IABSE in 2009 – this award Is the most prestigious international award for Structural Engineering.

I had the privilege of meeting Prof. Mota Freitas and to be able to honor him on behalf of CMM in 2007, by attributing him the status of Honorary Member of the association and by paying tribute to him in a public ceremony during the VI Conference on Steel and Composite Construction.

We will never forget the man who gave so much to Portuguese Engineering, an example of determination and strength to face and overcome all the adversities of life.

Luís Simões da Silva

A brief testimonial

I am not part of the vast number of people who accompanied Professor Mota Freitas throughout his brilliant academic and professional career. A great number of students and colleagues knew him a lot better than I did.

In any case, despite having met and been with him no more than a dozen times over the last thirty years, I have developed the feeling not only of great personal esteem but above all *great respect. I have witnessed, directly in these short periods but also in some others, attitudes revealing his strong character and also demonstrations of kindness, always sincere and well intentioned.*

I could always see, from another perspective, the dedication (passion, perhaps) that he had for the explanation, demonstrative and grounded, of the subjects to which he dedicated his entire professional life, namely those related to the behavior of structures, with its design and analysis. Not only the knowledge that was in the school curricula, but perhaps with even more interest, those that came from his own experience.

Another relevant fact of his personality was undoubtedly his good mood and the taste for get togethers. Despite the successive misfortunes that happened in his life, wherever he was there was always a story to tell (sometimes funny and didactic, at the same time), a joke to amuse everyonel.

I remember, with a longing smile, the periods of relaxed and lively get togethers that I shared with him.

The first contacts I had with Professor Mota Freitas occurred in the second half of the 1980s. At that time I studied and prepared an alternative constructive solution for a project of which he was the author. His open, even cordial reaction to the proposal to change his project and the plainness, lack of pretension, with which he commented on it, made me understand straight away the simple, uncomplicated personality of a great pedagogue.

Later Professor Mota Freitas joined the jury of the scientific aptitude tests and pedagogical capacity (perhaps this is not the correct designation) that I took at IST. I was then able to confirm everything I had witnessed earlier.

We met several times at the CMM Conferences, which he always encouraged and participated in while he could, on other occasions for reasons related to projects he was responsible for and in others simply to share a relaxed relationship with the participants. I was present in his last lesson. I can say that I have always witnessed the same open, frank, available, friendly and amusing spirit (less recently), concerned with professional and teaching matters.

We lost a national and international reference of structural engineering!
We lost a remarkable and humble pedagogue!
We lost an Exceptional Human Being!
We lost a friend!
We lost a Man!
LET US REMEMBER HIM AND PAY HIM THE BEST TRIBUTE: LET'S FOLLOW HIS EXAMPLE.

Tiago Braga Abecasis

Prof. Mota Freitas uniquely marked Civil Engineering and Engineering Teaching in Portugal and in FEUP, in particular, where he taught almost continuously in the period from 1968 to 2009, in parallel with his professional activity in the ETEC Study Office.

Having had the privilege of assisting Professor Mota Freitas in teaching subjects of Steel and Composite Structures, I witnessed his great dedication and desire to convey knowledge. Surrounded by students who were fond of him and devotedly learned the secrets of « being an Engineer », Professor Mota Freitas brought to the university practical engineering problems. His curiosity led him to seek the best international practices, and his willingness to teach resulted in his writing of thousands of pages of texts dealing with the most diverse aspects of steel and composite structures. In these pages, almost entirely handwritten, and in which all the drawings, markedly rigorous, were made by hand without the use of a ruler, Prof. Mota Freitas shed the knowledge that has formed many generations of civil engineers and that today is still up to date and interesting. We highlight documents on simplified methods of analysis, or empirical formulas for the design of sections, practical rules of connection execution, and many examples solved by him. We keep the memory of an Engineer who was a Teacher of reference in quality, integrity and humbleness and, for me, a FRIEND.

Elsa Caetano

HILTI invests on free training with on-line seminars

Hilti maintains its commitment to free training aimed at the users of its solutions by conducting on-line technical seminars conducted by specialists who make their technical and practical knowledge available on a wide range of topics.

More than 350 engineers have already participated in these training sessions during the years 2015 and 2016 and the agenda with the technical webinars for this year is already online at http://bit.ly/2jXR6G0.

Each webinar lasts approximately 45 minutes, addressing various technical issues identified by Hilti experts.■

Bulloni implements radiofrequency systems for warehouse management

In order to optimize its service, Bulloni implemented in the end of 2016, a new working model for its warehouse based on a radiofrequency system, which will allow to control and manage the inventory throughout the year, since this system gives the possibility of knowing in real time the movement of the stock and what exists in the warehouse.

This system is also beneficial in terms of social responsibility as it reduces dramatically the use of paper in material handling operations in warehouses or production processes.

Thus the productivity can significantly increase, it is possible to obtain very high levels of reliability of stock and complete traceability of all operations, thus improving its service, giving a faster and more effective response to the needs and deadlines of the customers ■

A1V2 sponsors EBEC Lisbon

EBEC Lisbon is a competition between students of technology universities of the BEST network located in Lisbon, that was held at Instituto Superior Técnico, from 25 to 27, March 2017.

EBEC Lisbon is one of the local events that will give access to EBEC Portugal (April) where the winner of this competition will compete at EBEC (August) in Brno in the Czech Republic. The EBEC – European BEST Engineering Competition – is an international engineering competition among the students of the European BEST technology universities. The BEST – Board of European Students of Technology – founded in 1989, is an association of European technology students representing 95 of the best technology universities in 33 European countries aiming to narrow the links between the triangle: universities, students and companies.

A1V2 has supported the Team Design category, one of EBEC Lisbon's participation categories. In this category, for 24 continuous hours, each team had to solve a technical challenge, through the construction of a prototype, with limited time and resources. At the end of the test, the best solution to the proposed problem will be awarded.

There were 18 teams of four members participating. The teams were evaluated, on March 27, by a jury, which included a member of A1V2. ■

BERD launches Department of Modular Bridges Solutions – MBS

BERD, a Portuguese company specialized in bridge construction processes, present in three continents and 100% exporter, created in 2016 a department specialized in Modular Bridges – MBS. With the objective of presenting competitive and alternative technical and economical solutions to the existing ones, the MBS modular bridges will have as main objectives the reduction of time, the simplification of assembly processes and to increase the range of spans available in the market. The entry of MBS products in the market is planned for the first half of 2017. ■

Eurogalva reinforces investment in new surface treatment area

Eurogalva, a company with a vast know-how in hot-dip galvanizing and a prominent position in portuguese market, opens a painting unit in Fiães, Santa Maria da Feira.

With an area of more than 12 thousand square meters and an investment of around 4.5 million euros, this unit will create 40 jobs and complete the portfolio of Eurogalva in surface treatments.

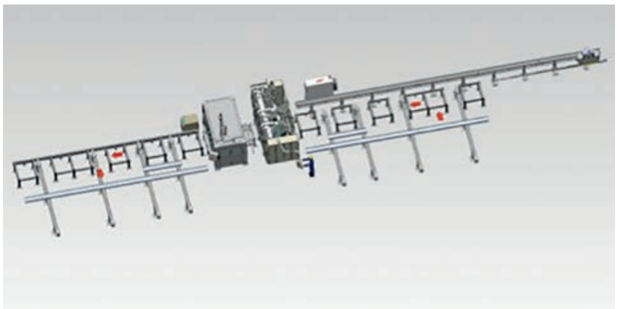
The new paint unit integrates the image of Eurogalva, which now rests on 3 universes – hot dip galvanizing, liquid painting and electrostatic painting.

The combination of hot dip galvanizing with paint – liquid or electrostatic – provides extra and longer lasting protection to iron materials as well as the possibility of aesthetic finishing.

Eurogalva thus increases its presence in the market, consolidates its competitiveness strategy and contributes to the increase of Portuguese exports. ■

DNC Técnica provides new equipment solutions to Socidias company.

The new project of the company Socidias is another example of the market positioning of DNC Técnica, with the supply of several solutions that integrate and complement in order to guarantee efficient and interconnected production and thus of high productivity.



The project consists in the installation of a cutting line of sheet by coil a turning machine with capacity of up to 3mm and a cutting and drilling line of Ficep.

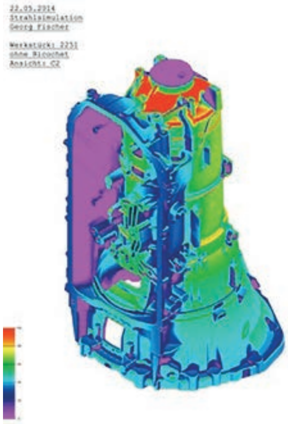
The ability to provide integrated equipment solutions, DNC Técnica stands out for having a technical department with more than 20 years of experience and know-how with the capacity to implement the same solutions: facilities, training, technical assistance.

Socidias relied on the structure of DNC Técnica for a solution that allows it to consolidate the reference position to be taken into account, as an operator in the civil construction sector. ■

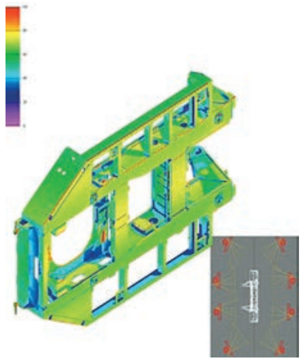
The computerized simulation of shot blasting

Wheelabrator, in its goal of constant innovation, now presents a computerized simulation solution of the blasting process.

The computer simulation of shot blasting is useful to the customer in several ways: during the blasting process, check which machine is the best for the intended application and production; In cases of improvements or reconditioning that are intended to be made to the already existing shredders, to know what could be the most appropriate to do; and in the study of the arrangement of parts, to improve the efficiency and effectiveness of shot blasting. The ultimate goal is to help the customer to have the most appropriate blasting process at the lowest cost possible.



In the simulation software the turbines are exactly positioned as in the real machines, since the main objective is that the simulation is as close as possible to the reality, taking into account the Gaussian distribution of the abrasive grain size, simulating the cleaning effect both by direct impact of the grit and by rebound of this on the walls of the chamber of the shredder machine.

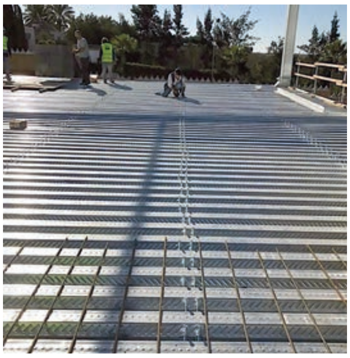


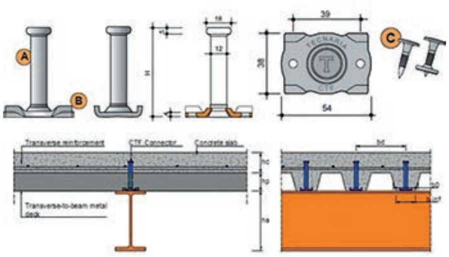
A 3D model of the parts to be shredded is passed through the "virtual shredder" and, during the passage, the various areas will acquire colors according to the intensity of cleaning, being able to correlate the different areas according to the efficiency of the blast. With this process it is possible to predict – especially in complex parts – the areas where greater cleaning is achieved and to improve the effect in areas where it is below the requirements (SA 2.5 or others).

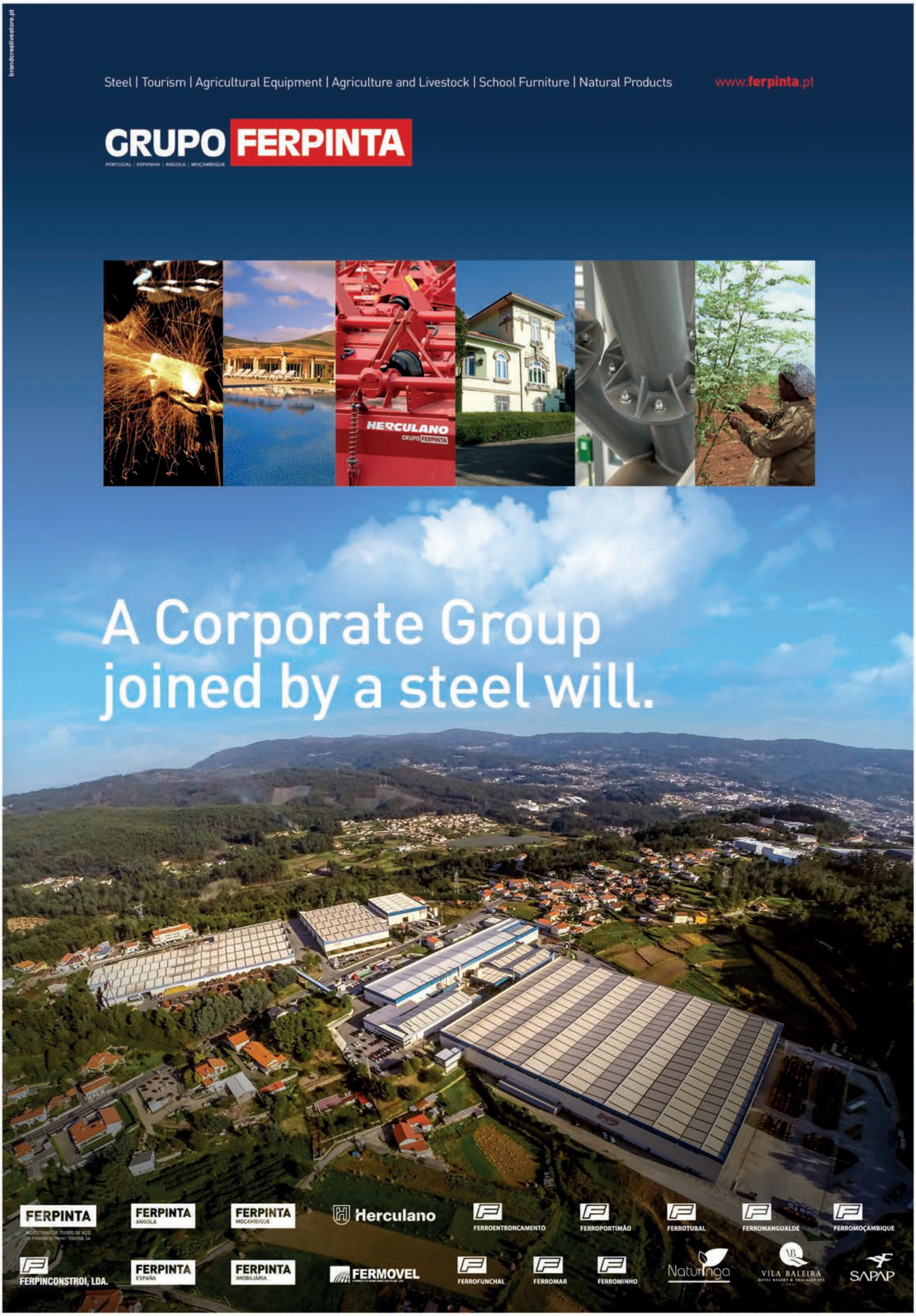
Available in Portugal by LUSOMELT, this tool especially in the case of complex parts, guarantees that the proposed shredder machine can actually carry out the work to which it is proposed according to the customer's needs. ■

Algarve Shopping Extension – the advantage of using CTF 105 connectors in mixed composite slab

Composite concrete-steel structures offer great static and economic advantages when compared to non-composite systems. A steel load bearing structure, properly attached to a concrete mold overlapped by connectors, ensures the static unity of the two different materials while allowing to explore its individual characteristics. The Tecnaria mechanical connectors marketed by Tecofix SA, simply connected to the beams, with high resistance nails (HSBR14) using the Spitfire 560 Gun associated to a kit specially developed for this purpose, allows to avoid the traditional welding of Nelson Type connectors. Thus, it's possible to obtain a more simplified solution of the constructive procedure and its consequent reduction of cost. The enlargement of the Algarve Shopping, work made by Planirest Construções SA, used this constructive process to produce a composite slab of 1400 m2 with steel sheet type Haircol 59S 0,75 mm on steel structure, application of mechanical connectors CTF 105 on the secondary sections of support of the composite Slab. The Tecofix SA technical support office verified the design of the Project and validated the solution using two CTF 105 connectors per rib. ■



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ITER – the world's largest nuclear energy fusion project with the participation of Martifer

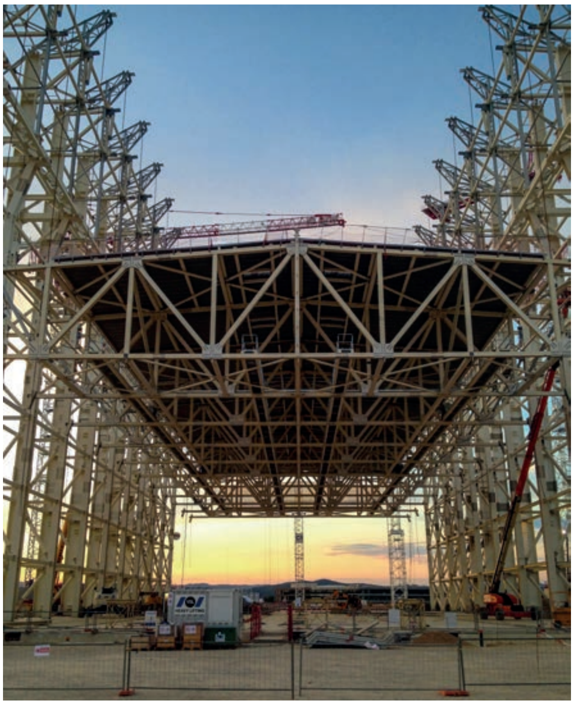
ITER (International Thermonuclear Experimental Reactor) is today one of the most ambitious projects in the world.

It is a project that aims for the construction of the world's largest experimental nuclear fusion reactor, a magnetic fusion device that was designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy, based on the same principle of the sun and the stars. It is estimated that the plant in southern France is due to start production in 2025.

ITER will be the first fusion device to produce liquid energy. ITER will be the first fusion device to maintain fusion for long periods of time. And ITER will be the first fusion device to test the integrated technologies, materials and physics regimes required for the commercial production of fusion-based electricity.

Thousands of engineers and scientists have contributed to ITER's design since the idea of a joint international fusion experiment was launched in 1985. ITER members – China, European Union, India, Japan, Korea, Russia and the United States – are now involved in a collaboration to build and operate this experimental device. Portugal is present in the construction of this project with the participation of Martifer since 2013.

Martifer was responsible for the design of joints, manufacture and assembly of approximately 5940 tonnes of steel structure for the building number 13 (Assembly Hall), 391 tonnes for the building number 17 (Cleaning Facility) and 343 tonnes for the building number 61 (Site Services). And for



buildings nembers 11, 14 and 74 there were provided approximately 7000 built-in boards.

The construction of the Assembly Hall was the biggest challenge for Martifer. With 60 meters of height, 97 meters of length and 60 meters of width, this construction fulfills with demanding standards of manufacture, assembly and quality. In addition to all the other works, which included about 2500 m^2 of rail, 4000 linear meters of guards and 18 sailors' stairs, the assembly of the roof was made using the "Heavy Lift" technique in order to facilitate the assembly work and to reduce the assembly time initially foreseen by the customer.

The 700-ton roof, consisting of 11 trusses up to 54.3 m in length, was all assembled on the ground and raised only once by a synchronized hydraulic system, in a continuous process of 16 hours, in which 21 people were involved.

Another feature of this building is that it is equipped with 2 cranes of 1500 tons. These cranes are supported by 20 rails with about 21 tons each, which were assembled at 40 meters high.

The completion of a project with the importance of ITER demonstrates Martifer's ability to construct emblematic works with a high degree of technical requirements. ■

Pompidou Center: The structure of art – the art of the structure

Marta Gameiro
Civil Engineer, Partner and Technical Director at Gravidade International, ex-employee from RFR Ingénieurs.

1. Architectural landmark, a landmark of engineering

The Georges Pompidou Centre was an architectural landmark in Europe in the 70's, which was obvious in the article by Professor Vitor Murtinho published a year ago in this journal, in edition No. 40. In this article, we intend to show the impact this building had in the structural engineering of that decade as well as the landmark it became in the development of the use of steel in construction. We also highlight the intense collaboration between the two subjects, architecture and engineering, which allowed the completion of this exceptional building.

2. The competition

In early 1971 the French Government launches an international public competition for a project of a cultural center to be built in Paris, in the area known as Beaubourg. The main intention was to place at the disposal of the population a source of information and cultural dissemination, in a friendly environment, open to everyone and leaving aside any elitism or consideration of class.

In London, at Ove Arup & Partners, Structures 3 was a team led by engineer Ted Happold, dedicated to the exploration of new trends, such as the study of singular structures in textile membranes and cables, together with Engineer Frei Otto in Germany.

Peter Rice was then a young engineer at Structures 3 who stood out in the difficult mission of making the daring structure of the Sydney Opera of the architect Jorn Utzon, to which he devoted himself seven years after his graduation from Imperial College in London .

Structures 3 saw in the competition of the so-called Beaubourg Center, a clear, well organized process that offered a good opportunity for experimentation. He then challenged the newly formed pair of architects Richard Rogers and Renzo Piano to come up with a proposal together. After some hesitation, but yielded to Happold and Rice's insistence, the challenge was accepted.

The contest was very disputed, with 681 proposals being presented. It was not surprising that this would be the most emblematic and far-reaching work ever undertaken in Paris after the last war. The jury was composed of prominent figures of the architecture and engineering of the time, like Philip Johnson and Oscar Niemyer and presided by the remarkable engineer, inventor and French designer Jean Prouvé.

The spirit of the young team was, however, unpretentious. Knowing that winning this type of competition was as unlikely as winning the lottery, they approached it without commitments, seeking to explore new ideas that would respond to the central concept chosen for the project: designing a cultural information machine.

For the superstructure, a large-span steel solution was presented for the entire width of the building, with floors supported by flat truss beams resting on tubular pillars on the facades. The concept of flexibility was exploited

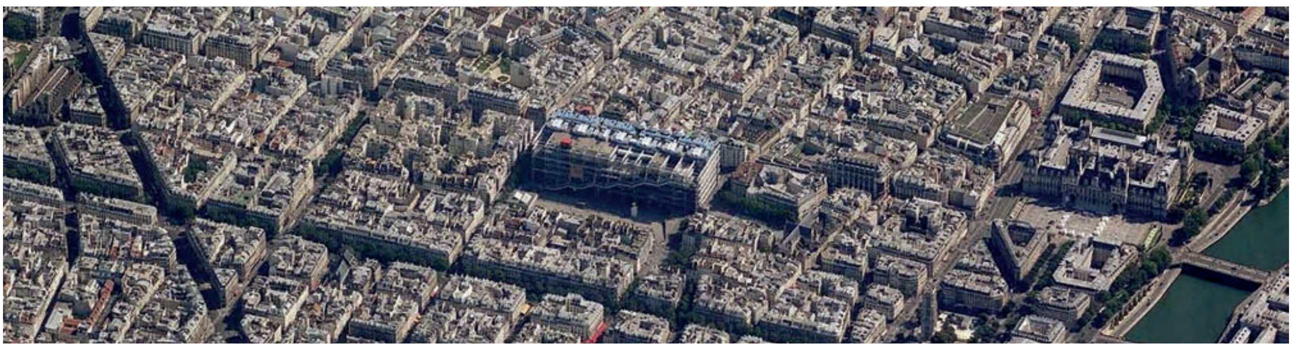


Figure 1. Aerial view of the Pompidou Center and the urban environment around it

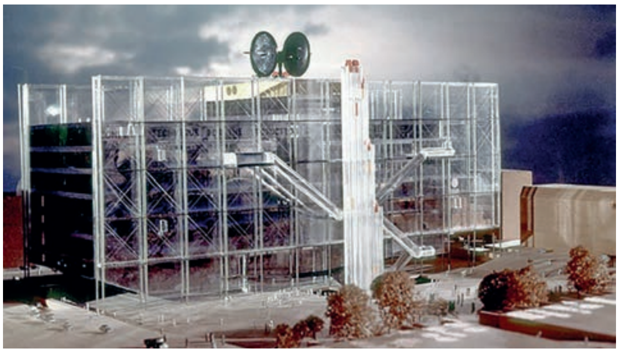


Figure 2. Model of the proposal submitted to competition

to the limit, proposing the possibility that floors, walls and partitions could be movable, that is, their position modified according to the needs of each moment. The connections between the various elements of the steel structure have since then become of central importance in the proposal.

Against the expectations of many, including themselves and especially of the French government, the selection of the jury went for the proposal of Piano, Rogers, Happold and Rice. The team's first major challenge was to ensure the exclusivity of project development from design to execution.

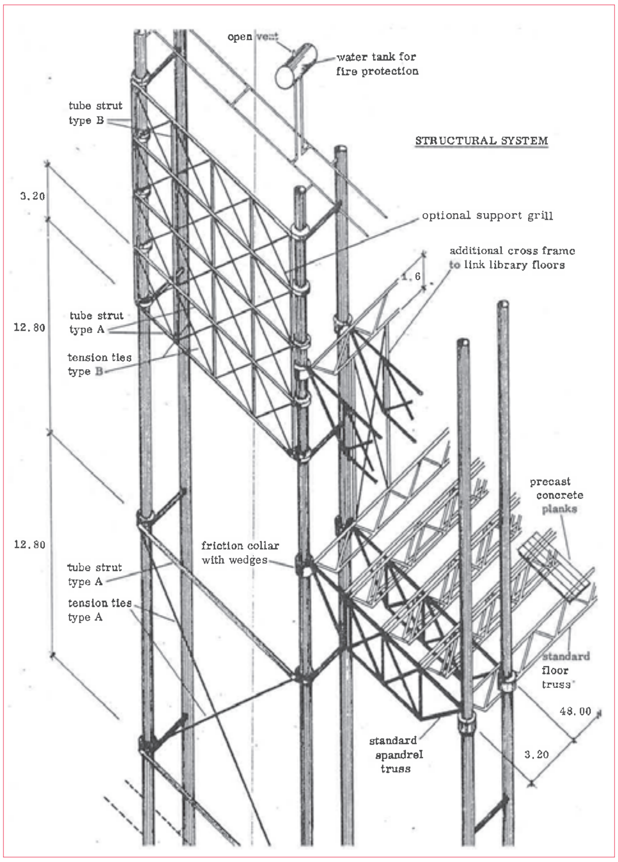


Figure 3. Structural System of the proposal submitted to competition

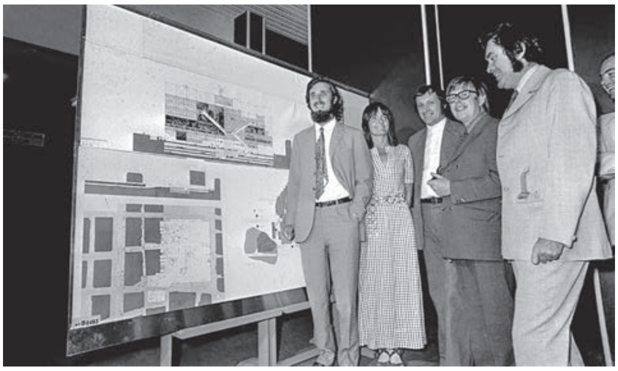


Figure 4. The winner team – from left to right: Renzo Piano, Richard Rogers and wife, Ted Happold e Peter Rice.

3. The challenges

Flexibility and versatility were one of the project's key points. The single span between front and rear façades, with 44.80m, met this requirement, allowing multiple and evolving uses of the building's interior space

In the façades the vertical circulations were concentrated and exposed: on the front facade, the circulation of the public, by means of escalators, in the posterior facade, the circulation of load and the technical infrastructures. The central 44.80m span thus had to extend at both ends to integrate the circulations.

Loads of great magnitude were to be considered, since an important part of the program consisted of a library and documentation center, which could work on any of the floors of the building.

On the other hand, the clearance was fixed at 28 m, maximum height of a fire escape car ladder. Should this height be exceeded, the building would be considered to be of great height and would have to meet numerous additional requirements regarding fire safety. The height between floors was therefore limited.

Finally, the "information machine" should, despite its large scale, have a human scale, be a popular place where the visitor feels welcome, not intimidated. The structure being largely visible, it was a decisive element in achieving that goal. It was in response to this challenge that Peter Rice printed his most significant personal mark on the project.

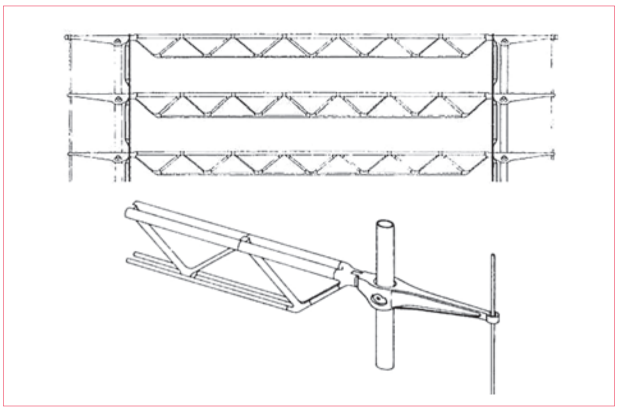


Figure 5. Cross-section model and detail showing the relationship between the main truss, the *gerberette*, the pillar and the tension rod

There were, as in all projects, cost and time constraints. It should be noted that the deadline for opening to the public was five years after the launch of the contest, which, today, seems like an eternity, but in the 70's it was a challenge.

4. The answers

The large span of 44.80m was overcome by flat tubular section trusses. The double strings, with a slight distance between the two tubes, gave a noticeable visual lightness to these elements about 3 meters high.

The trusses and pillars were made with tubular sections of steel, produced by centrifugation. The connections between the double chords and single diagonal bars, centered on the main trusses were materialized through cast steel parts. On the other hand, the vertical circulations next to the front and rear facades of the building were supported by pieces called *gerberettes*, also in cast steel.

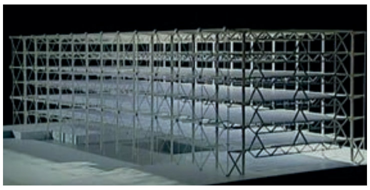


Figure 6. Model of the final structural system

Figure 7. Decorations in cast iron in the Paris metro

The term *gerberette* comes from the German engineer Heinrich Gerber who invented the gerber beam and used its patented system in the construction of numerous bridges from the second half of the nineteenth century. The *gerberettes* were in this case the parts in which they unloaded the main trusses, which transmitted these reactions to the tubular pillars of the facade and were locked at the opposite end by vertical tension rods. Each element thus had a perfectly defined function: truss beams working in flexion, tubular compression pillars, traction tension rods. The contact between the elements was made in a punctual, simple way (articulated supports) and ensured by cast steel parts.

The structural system showed a feature much appreciated and defended by Peter Rice: predictability. A perfectly established hierarchy, a well-defined function for each part, the ability to precisely control the efforts to which it will be subjected. An important factor of reliability.

The choice of cast steel came, in turn, to respond to the desire to confer human dimension, "tactile" quality to the structure.

In effect, Peter Rice had long wondered about what gave the great nineteenth-century structures their particular appealing character. Paris had numerous examples: the entrances to the *art noveau* metro stations, the plaftform of Lyon, the Eiffel Tower, the Grand Palais ... Its audacity did not explain everything. Numerous postwar structures were audacious but lacked the personality and warmth of their counterparts of the previous century. He concluded that what transpired in the latter was the commitment and care that the engineers had placed in his drawing. Just as the Gothic cathedrals, structures Peter Rice admired, manifested not only the functional choices but also the personal and subjective character of the masters and artisans who shaped them. Through the merged decorating elements and the iron connections, through the carved stones, each work expressed a personal mark, reminding us that it had been idealized and erected thanks to the work of the men who participated in it.

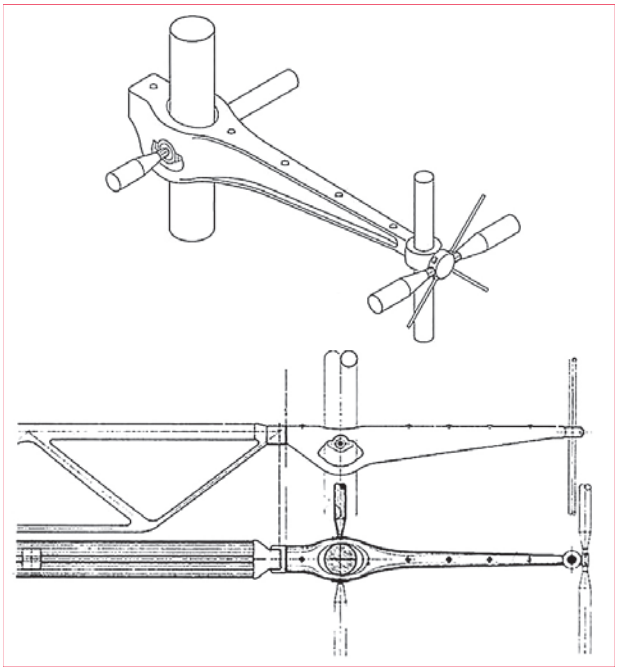


Figure 8. *Gerberette*

The cast steel could manifest these same qualities. The *gerberettes* were thus given every care during the development of the project. Its shape was studied in detail and refined for months. Obviously, the final result was the incarnation of the function of the part, faithfully translating the diagram of moments in it installed. Thin at the support point of the trusses, high and wide in the connection to the pillars, again refitting to the connection with the outer tension rods. The form also responded to the conditions of the casting and assembly process.

This is the symbol part of the structure, a product of the industry of the time, but an unmistakable witness to human intervention. The scale of the building would be perceived by the scale of the individual elements and not by the size of the whole.

5. The difficulties

The road to the realization of this important landmark of architecture and engineering was, however, tortuous.

The first barrier, present during the more than four years between the announcement of the winners of the competition and the inauguration, was the resistance found in the French entities involved in the process, with the exception of the Welding Institute. In fact, the government and the national engineering community did not expect that the victory of a competition of this nature would go to a foreign team. Rocovered from the shock, they tried to relegate the intervention of the team, and in particular of the engineers, to the mere follow up of the project, which would be developed by "excellent French engineers". However, Structures 3 showed that the heart of the project was precisely the detail, so its intervention had to be total from conception to execution.

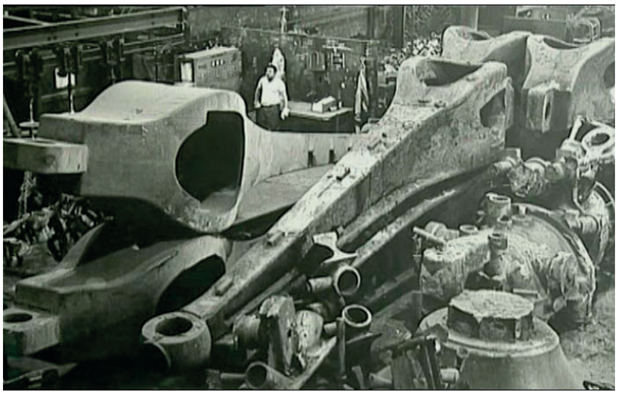


Figure 9. Gerberettes in the foundry Polig Heckel & Bleihart

Fortunately for Beaubourg, the competition defined the creation of an independent public entity to manage the whole process of installing the museum, from the project to the work, from the exhibition program to the acquisition of the art collections. Its president, Robert Bordaz, who reported directly to the President of the Republic Georges Pompidou, quickly grasped the point of view of the winning team, and has since then been his strong defender.

The competition also provided for the installation of the design team in Paris. Architects and engineers, the second led by Peter Rice, then undertook the work. The pressure was constant from the client, the consultants (experts and representatives of the French industry) from the project reviewer (Socotec). Fierce reviews were made about the feasibility of the steel structure. In particular on castings. Indeed, cast iron was then a technology of the past, abandoned for decades, and still produced in old and rare foundries of central Europe, with archaic methodologies. It was the antithesis of the modern steel industry, based on the industrial production of rolled parts, standardized, reliable. It was therefore necessary to modernize production and adapt it to current reliability requirements. The client stipulated that the castings be subject to a rigorous testing program to attest its suitability.

Here, as always, the responsibility of the engineer is very clear: to ensure that the structure is safe whatever the load conditions to which it is subjected. If in addition it is elegant and reflects the specific characteristics of the material from which it is made, the better.

Figure 10. Finishing of a *gerberette*

At the consultation stage of contractors, all foreign companies withdrew from the competition. The two main French companies agreed and presented an identical price that surpassed the established budget by fifty percent, both proposing in parallel alternative solutions that fit exactly in the available budget. The work owner declared the contest invalid and challenged the designers to find out who was available to build the project solution within the available amount and deadline.

At this point it is worth noting that the protectionism exercised by French engineering and industry is not unique to this country. It is a phenomenon common to other geographies. In general terms, companies tend to be conservative and dogmatic at home and to be open and flexible abroad. Globalization has blurred this way of acting, but in essence the rule remains valid.

Having found a German company that met the requirements, Krupps, the studies of the castings were completed and the first *gerberettes* were produced in the Polig Heckel & Bleihart foundry. Resistance tests revealed that the parts did not support more than half of the load for which they had been designed, fearing a tragic outcome of the whole process.

Figure 11. Operation of main beam attachment to the *gerberette*

A final difficulty was also present: President Georges Pompidou, final customer of the order, died in May 1974. His successor, Valéry Giscard d'Estaing, considered the project an unnecessary expense and required that two floors be removed from the building. Fortunately, the process was already too advanced to incorporate the amendment, so the project was implemented as initially planned.

Finally, the obstacle of communication, or, in fact, the lack of it. Communication failures that are the origin of many of the problems we face in countless situations of our daily lives. In this case, the main responsible for the failure of the first *gerberette* testing campaign, as will be seen below.

6. The solutions

The reader asks himself at this point how it was possible to carry out this undertaking.

Firstly, I would emphasize a decisive factor, without which all the competence and commitment of the project team and companies involved would be frustrated: the quality of the work owner. We have already mentioned the clairvoyance of the president of the public entity formed to manage the process and perseverance with which he ensured the conditions for the project to follow the course defined in the program of contest. In addition to the personal value of this figure, the system itself was also meritorious: the creation of a management body independent of political power and advised by individuals of recognized competence and exemption, including the aforementioned chair of the selection board, who allowed the public interest to prevail over other interests.

Secondly, but not less important, the competence, the critical and experimental spirit, the scientific and rigorous analysis with which the technical challenges that the project presented were tackled and solved. The most relevant among them consisted in the challenge of making cast steel a reliable material suitable for use in the modern construction industry. This was surpassed by the engineers integrating in the analysis a new methodology, coming from other industries. This was recent technology applied to metal production based on the fracture mechanics theory developed to meet the need to produce reliable steel platforms for nuclear reactors as well as for the North Sea oil structures. The fracture mechanics allowed to predict the behavior of the fragile materials submitted to stress states and their operation in the presence of internal defects, such as small cracks.

In the design phase, the calculation of the cast parts was carried out using this methodology and their specifications, stipulating the use of the recent English standard on cast steel, defined with precision the characteristics of the steels and procedures to be used in the casting.

Thus, in the manufacture of the first prototypes of the *gerberettes* and knots of the trusses, there was another problem mentioned above: communication lapses. Krupps engineers and casting technicians did not read the specifications, so laboriously prepared by designers. Written in French as stipulated in the competition, it was not easy to apprehend by the German-speaking. In their turn, the designers did not speak German and the communication was made through the precarious English of the Germans. Finally, they did not think twice about using the German standards to which they were accustomed, and which was, moreover, well known for being the most demanding and precise in Europe. Who would question the fairness of the prestigious DIN?

After the disastrous result of the first tests, Peter Rice and his team went to Germany to analyze the problem.

Figure 12. Construction site in the final phase of the work

They understood the origin of the error and explained it to the German engineers, who were still irreducible in their convictions. The search for a solution led them to the University of Stuttgart, the Institute of Materials, where they found Professor Kussmaul, who used the methodology of fracture mechanics. He was able to explain to his compatriots the problem in question and persuaded them to adapt the procedures to the English standard.

The second set of *gerberette* prototypes was thus produced and the tests were carried out without incidents, obtaining the resistances foreseen in the project.

From this point on, no further technical setbacks were found and, apart from the temporary panic set up at the time of Pompidou's death with the prospect of the project being disfigured by the removal of two floors, the work continued normally and was completed in time for the foressen date of inauguration, on 30 January 1976.

7. Peter Rice

After the completion of the Georges Pompidou Center, Peter Rice founded with Martin Francis and Ian Ritchie his own office in Paris, the RFR, responsible for the design of emblematic structures in France and around the world. He was a pioneer in the innovative use of various structural materials such as cast steel, glass and stone. He was a singular, brilliant engineer, respected by

Figure 13. The completed Machine of cultural information

Figure 14. The Structure of Art – The Art of the Structure

Figure 15. Rogers, Piano e Rice on the *gerberette*

his peers, requested by the most outstanding architects of his time. Through his work, his legacy, he taught us a great deal about the role of the engineer in the profession and in society.

The Georges Pompidou Center, as well as many other projects in its curriculum, are a living example of how the intimate and collaborative work between architects and engineers produces exceptional results, which transcend both subjects.

References

Peter Rice – Mémoires d'un Ingénieur
Peter Rice. Tradução do inglês An Engineer Imagines, por Luc Baboulet
Groupe Moniteur, Paris 1998

Peter Rice : Un ingegnere tra architettura e technologia
Niccolo Baldassini
Università de Firenze, Facoltà di Architettura, Thesis 1991

Traces of Peter Rice, an Arup Documentary
Ben Richardson, Kelsey Eichhorn, Jennifer Greitschus
Arup 2012

Prof. Vitor Murtinho
University of Coimbra and
Arq. Joana Maia
University of Coimbra

A House for tea in Montemor-o-Velho

"The architecture is the will of the time translated into space."

Mies van der Rohe*

Who travels along the road EN 111, an important road linking Coimbra to Figueira da Foz, when arriving at Montemor-o-Velho what remains in one's memory is the grandeur of a walled enclosure that stands out on a hill located on the South side of the road, contrasting with the flatness of the fields that lay from the riverbed of the Mondego. This apparatus is more prominent for those travel from the coast towards the interior.

The town and the county head office of Montemor-o-Velho during many years was confined to the slope of a hill facing Southeast, tucked between the right side of the Mondego River and the high robust fortress that functioned as Sentinel. In the Highlands of this hill, setting its crowning achievement, is developed and enforced a walled space that despite its ancient appearance its long age is compatible to the respectability that time allows to carve. This fortress of great strategic value, was located in a geographic area subject to multiple variations of possession, even in times prior to the beginning of Christianity. Until the final conquest of the Kingdom of the Algarves, Mondego functioned as a kind of hinge subject to frequent advances and setbacks of a Christianity that deployed in the territories in the North and swindled the Islamic people located in the South.[1] We should not ignore the importance of the River Mondego, at the time due to its navigability from Figueira da Foz to, at least, Coimbra.

When the King D. Sancho I decided to leave at the beginning of the first decade of the 13th century, by inheritance, the village of Montemor-and other lands-to his daughters, infantas D. Sancha and D. Teresa, motivated the energetic protest of his brother Afonso II given that this transfer conditioned the survival of the Kingdom. In 1212, by decision of the infantas, would be granted a Charter to the village of Montemor, confirmed later in Coimbra by D. Afonso III in 1248.[2]

The castle of Montemor, classified a national monument since June 16, 1910, hosts in its interior the Church of "Santa Maria da Alcáçova", ordered to be built in 1090 by Count D. Sesnando and rebuilt in the first quarter of the 16th century with works attributed to the architect Francisco Pires.

* Quotation extracted from *Escritos, Diálogos y Discursos*, Colegio Oficial de Aparejadores y Arquitectos, Murcia, 1993, p. 25.

1 Góis, Correia, *Concelho de Montemor-o-Velho. A Terra e a Gente*, edition from Town Hall of Montemor-o-Velho, Montemor-o-Velho, 1995, p. 217.

2 Conceição, Augusto dos Santos, *Terras de Montemor-o-Velho*, edition of the author, Coimbra, 1944, p. 50 e sgg.

Figure 1. Sight of the village and the Montemor-the-Old Castle, image from the side of the river Mondego. The "Paço das Infantas" and the Tea House are located between the tower of the Church of "Santa Maria da Alcáçova" and the Clock Tower.

Figure 2. Aerial view of the castle with a Tea House and "Paço das Infantas" situated in the center of the wall and on the right side of the Church of "Santa Maria of the Alcáçova".

Figure 3. View from the terrace and the entrance of the Tea House. Photo by João Mendes Ribeiro

The Castle, with an irregular plant configuration, features a first division named main fence with elongated shape according to northeast-southwest axis, where there are towers of circular or quadrangular shapes that rhythmically must have been built in order to create outstanding points throughout the perimeter area of the wall of the Castle. To work around the outside of the main fence there is a Barbican where two doors appear: one to the Southeast (facing north) called *door of plague* or *door of Coimbra*, placed against the Manor house, and another door to Northeast known as *Sun door* or *Our Lady of the Rosary.*[3] Until the mid-20th century, in the area adjacent to the Church of "Santa Maria" and delimited by this church and by the Manor house in the designated "castelejo", was the graveyard of the village. On the Northwest hillside of develops a surrounded area that once served to house, in case of need, the people of the suburbs and their herds. Roughly in the middle of the wall which below defines the surrounded area we have what still remains of the lower stronghold of the fortress. South of the Church and almost overlooking the walls of the Barbican are located the ruins of the "Alcáçova", also known as "*Paço das Infantas*".

The Manueline reform of the latter space, cause its configuration to force its extension to the Southeast limit of the Barbican.[4]

It is said that it was in this ancient seigniorial residence that on January 6, 1355, D. Afonso IV yielded to the indecorous pressure of his advisers to have the mythical figure of Ines de Castro killed, leading to a rather bloody process and a grim coronation that has ever since been magnified thanks to an intense popular imagination.[5] If we follow the wall line to the west we have the Clock Tower, which was orderes to be built at the end of the 19th century by the town hall and adjacent to the Chapel of St. Anthony (located on the surrounding barbican and implanted outside the castle).

In geographic terms, the castle is situated on a liassic hill, which enjoys excellent sun exposure and is at the highest level for all topographical accidents in the vicinity. This peculiar situation, aided by the adjacent flatness of the fields of "lezíria" of the Mondego, makes the castle function as a kind of wide, open and dominant balcony of the surrounding landscape.

3 Matos, João Cunha, *Montemor-o-Velho. Sua História. Sua Arte*, reedition of the Town Hall of Montemor-o-Velho, Montemor-o-Velho, 1990, p. 22.

4 Góis, Correia, *Concelho de Montemor-o-Velho. A Terra e a Gente*, p. 222.

5 Matos, João Cunha, *Montemor-o-Velho. Sua História. Sua Arte*, p. 18.

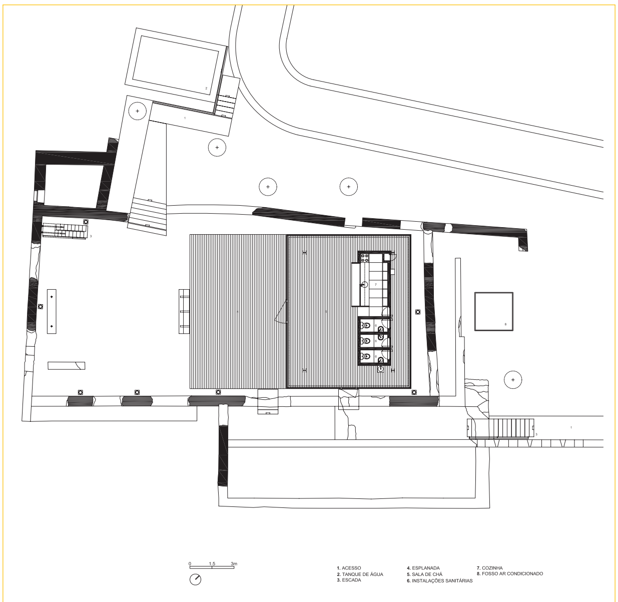


Figure 4. Plan of the Tea House with external arrangements and drawings of the ruins of the "Paço das Infantas".

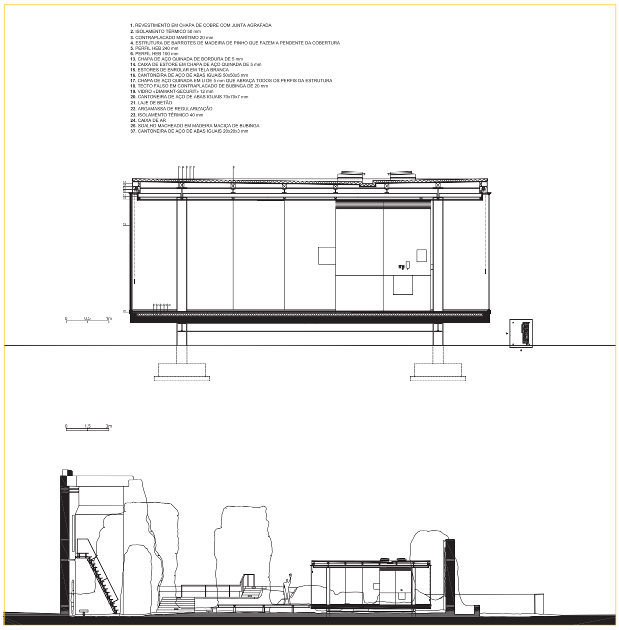


Figure 5. Cut the Tea House and including ruins of the "Paço das Infantas".

As as result of its singular position and aspect, the castle of Montemor has been the object of a great tourist demand. However, almost all of the visits are limited to a simple route of entry into the fortress through the *Door of Plague*, to an ambulatory route inside the walls and to the enjoyment of the splendid views. Rarely does the visitor venture to cross the *Gate of Our Lady of the Rosary* and to walk through the historic center of the village.

Given the proven touristic attraction of the castle, and due to the inexistence of a supporting infrastructure that could endure the stay of the visitors and eventually allow the recovery of the energies to start the tour through the historical center of the village, a contest was developed in order to build a tea house. The winning proposal, which intended to occupy a significant part and with great symbolic value in the castle, was developed by the architect João Mendes Ribeiro (JMR).[6] The solution found intended to enhance the surrounding landscape and take advantage of what was left of the "Paço das Infantas". As a functional program, there was the desire to offer the visitors a qualified space of equipment of services that allowed to enjoy the tranquility of such a beautiful landscape and, simultaneously, to be able to enjoy a drink accompanied by any of the famous regional convent sweets: "queijada" and "pastel de Tentúgal" or the famous "*espigas doces*" or "*pinhas*" of Montemor.

Given the immensity of the space of a castle that is probably the largest in national terms, it must not have been easy to start with a simple program, with little constructive need, and define the best place to welcome and value it. In the intense challenge of the persecution of form and the best place, in the convulsions between intuition and rigorous investigation, there were awakened facts and assumptions, visualizations and symbolisms, which awakened the awareness that the most serene solution would be confrontation: the assumption of an accomplice tension between the preexistence and new architecture. In architecture, the crucial aspect of an intervention is the salutary confrontation of times, of historical time and of a new time. At creation, it is important to connect to the present time. In the spirit of any manipulator of forms must underlie a complete response to the starting demands and the principles of utility, actuality of appearance and relation to the place must be satisfied.[7] In any circumstance, it is important to give way to the easy way of using stereotyped solutions and to opt for the diligent search of materialities and formal structures that integrate into the type of landscape context.

Specifically, the idea for the project was to take advantage of the ruin of the "Paço das Infantas", occupying the interior void when implanting the delicate program of the project. The solution was to implement a light volume, with a very geometrized shape, leaving loose the remaining walls of the court. In this proposal it is evident the development of a conceptual process of great craftsmanship, denoting its aesthetic focus in creating a unique and unrepeatable atmosphere. Interestingly, although the author states that the principle of composition that generates the project is a rectangle whose proportion is regulated by the *gold number* (usually represented by the letter *fi* in honor of the architect of the *Parthenon* of the acropolis of Athens and where it is assumed that this relation may have been used)[8], in reality this proportional system is only possible to find in the relation of the rectangle

6 The project is from 1997 and the work was built between 1999-2000.

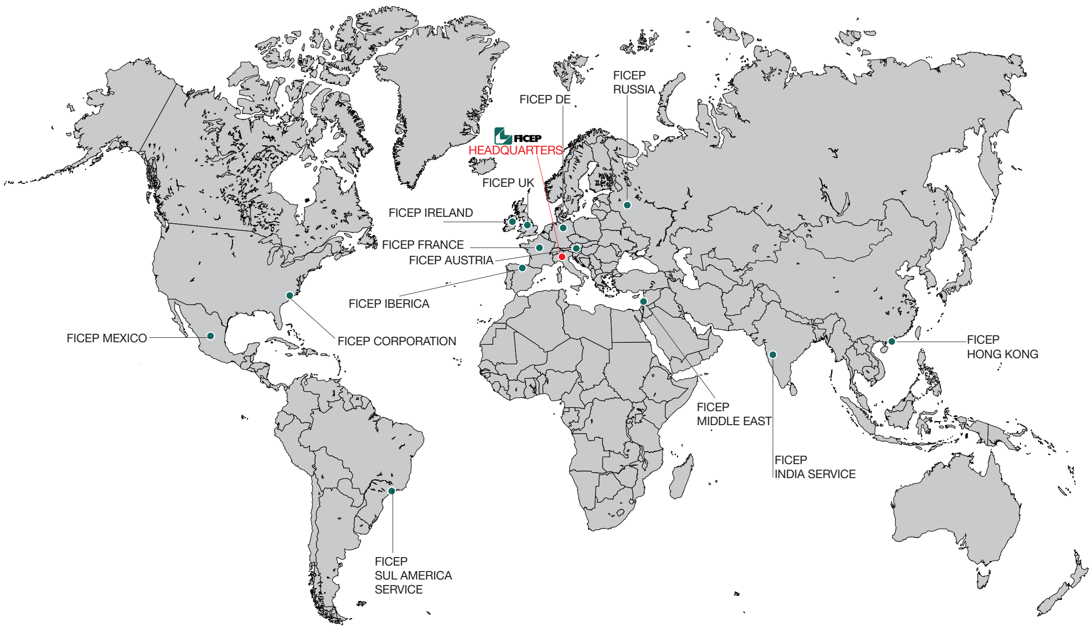
7 Zumthor, Peter, *Pensar a Arquitectura*, Editorial Gustavo Gili, Barcelona, 2005, p. 22.

8 The particularity and reason for the success of this proportion has to do with the fact that if we withdraw to this rectangle a square we obtain again a new rectangle with the same proportion. On the use of this base, this is explicitly mentioned in the descriptive memory in the proposal of the contest (Ribeiro, João Mendes, in *João Mendes Ribeiro Arquitecto*, Edições Asa, Porto, 2003, p. 97).

FICEP

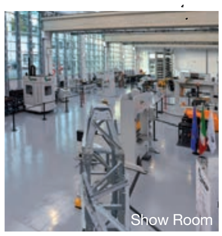

Headquarters

Headquartered in Varese, Italy, Ficep is the leading manufacturer of machine tools for the steel construction industry with customers in nearly 90 countries globally. The company provides the world's widest range of machines for both the structural steel and forging industries.




Academy of Technology


Manufacturing & Assembling Plants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Conference Room


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Figure 6. Structural steel solution with perception of construction system adopted for the coverage of the building.

Figure 7. Photo of the work with steel structure of the roof and the Terrace in sight.

Figure 8. Corner of the building and the terrace with piece of ruins in the background. Photo by João Mendes Ribeiro

that corresponds to the terrace. What is verified is that the overall rectangle that generates the shape which coincides with the implementation of the proposal (terrace and Tea House) corresponds to a rectangle *patio of 2* (proportional relation analogous to, for example, a standard sheet A4).

In reality the intervention corresponds to the implementation of a space delimited by the ruin of the "paço", functioning as a physical and conceptual envelope of a construction that in essence is dematerialized. A constant feature in the work of JMR is his concern with scale, giving great prominence to the relationship between space and human body. In the context of the work of Montemor, it is evident the exploitation of the relational capacity of the spaces, articulating all the potential of references made available by the historical site.[9]

In addition to some delicate elements that organize or enhance certain routes, the proposal roughly corresponds to a box with glass walls with opaque cover and floor of dominant steel structure. In order to standardize the exterior coating, the support structure, composed of four steel H sections, appears visible within the interior space, clarifying the principle of structural autonomy with respect to the division of the space or to the skin surface which defines the shape of the building . In front of this box, a terrace appears - physically detached from the interior space - that occupies the entire southwestern front of the building, defining a terrace that offers a wide and unobstructed view of the Mondego rice fields. Thus, for the interior floors and for the terrace bubinga wood is used, which gives it a reddish, warm and contrasting complexion. On the terrace and facing the west, the verticality of a wall is imposed with a steel ladder attached with discontinuous steps, which quickly ensures the use of a previous span of the first floor of the ruin, thereby increasing the dimension of view and emphasizing the scenographic nature of the intervention.

For people familiar with the issues of spatiality and architecture it is impossible to observe the Tea House of Montemor without finding serious and inescapable Miesian influences. In reality the presence of that crystalline volume, in multiple aspects, refers to our imaginary of the house that Mies van der Rohe designed for Dr. Farnsworth in Plano, Illinois.[10] Both proposals start from an almost iron logic of formal purification, and there is intentionally a willingness of all the constructive characterization to be developed according to a logic of minimized details. In terms of a palette of materials, the very meticulous study of the project will aim at the use of a minimum of textures, colors and materials in such a way that this synthesis corresponds to an architecture that has a very unitary character, serene but clearly distinct from preexistence. In the case of the Farnsworth house, the solution is very minimalist from the chromatic point of view, since white is a dominant color, contrasting with the honey color of the interior panels that allow all the functional organization of the house. In the case of the Tea House, what transpires is some constructive truth, also very perceptible in the way each material is applied. Here, there is also a single interior volume, materialized in ash wood, which houses the sanitary facilities and the canopy that supports the bar. To maximize the crystalline effect of the Tea House and thereby formally accentuate its monolithic characteristics, the entire surrounding structure is drawn without the use of plumb or window frames. In this specific context, there is some *ambiguity between outer and inner space*[11], since the limits are dematerialized and are restricted only to the question of an air-conditioned zone or a zone subject to bad weather. To maximize this effect is sacrificed the use of double glazing, using a laminated glass of extreme transparency. In the facade, the only vertical elements that are distinguished are the window frames of the two exterior access doors. The cover of the volume is in a copper chamber that, with its brown coloration, helps to dilute the contrast that this plan could have with the stone elements of the castle and the court. In the general context there is an inexhaustible capacity to reinvent the existing, by making an architecture with scale. A humanized scale

9 Tostões, Ana, "Neutro e excepcional ou o esplendor da verdade" in *João Mendes Ribeiro Arquitecto*, p. 9.

10 About this important miesian house see explicitly Murtinho, Vítor, *Farnsworth House: um templo para habitar*, Metalica, nº 38, 2015, pp. 22-29.

11 Ribeiro, João Mendes, *Arquitectura e Espaço Cénico*, Universidade de Coimbra, Coimbra, 2008, p. 350.

that takes into account the size of the bodies and the satisfaction of the functions that are attached to it. The proposed experiences are denounced beyond the programmatic particularities and reveal a great formal improvement, evidencing a poetic and sensitive matrix. The initial difficulty was to be able to make sense of a new part, making a coherent whole in the end, even if it is constituted from many parts.

In the context of the intervention, the option to place the Tea House inside the "Paço das Infantas" corresponded to a very correct solution. In this sense, this position, given that it occupies a space that was empty, allows to highlight the two constructions - preexistence and new construction - forcing them to establish a position of dialogue. The proposed constructive solution, which by its nature has a potential for reversibility, creates punctual situations of tension between the two structures, at the same time that the chromatic and material difference allows each of them to be observed autonomously. The way that the new construction appears, showing an independence with respect to the preexistences, gives it an innocuous. The ruin that remains of the "Paço das Infantas" presents a fragmentary character due to the discontinuity of the wall plans. The proposal of JMR works as an aggregator element, helping to design a structure that grabs all

Figure 9. Hall of service zone with entrance door to the toilets.
Photo by João Mendes Ribeiro.

Figure 10. Alignment between Tea House and ruins, with perception of transparency of the interior space.
Photo by João Mendes Ribeiro.

dispersed architectural elements, giving them unity, thickness and content. In another case, in terms of appearance, the fact that the constructed structure is over-elevated relative to the ground reinforces its intention not to cause any harm, accentuating its harmless character. The building has an aspect that greatly reinforces the horizontal lines, clearing and opposing itself to the verticality of some of the remaining walls of the court. This work of contemporary design, takes advantage of all the accidents that

Figure 11. Ruin of the "Paço das Infantas" and steel ladder to access the top. Photo by João Mendes Ribeiro

circumstantially time has been carving. Enabling framings and highlighting the aspect of ruin, without concerns of restitution of memory, masterfully manages to revive the space in present time, now as a reclusive and intimate space as a tea house.[12]

The work of JMR has had a great development in terms of theatrical productions and set design. This experience has helped to direct much of the practice of this architect, both by having a strong expression for the number of scenographies already completed, and also - and above all - by the influence of this practice in his work. Somehow, Montemor's intervention transforms the architecture into a scenographic object. The scale of the intervention and the experiences potentialized by the use of the space creates the subtlety that the whole place resembles a scenic choreography. In the theater, the starting point is a preexisting space that will change, allowing the spectator, during the play, to move to another reality. In Montemor, as if it were a set design, the existing involucre is assumed as a perennial structure that will help to leverage a scenic object whose nature has a potential for ephemerality. Now this difference, on the whole, defines another reality, transforming the existing place and almost defining a new place.

At the level of contact with the soil, it was surgically defined the points of foundation that, together with its compactness and without causing any damage to the existing underground structures, can easily be deconstructed, allowing the restoration of the previous situation to the Tea House. Having achieved his architecture, JMR uses an essential synthesis whose main idea is to obtain the maximum effect with a minimum of means. In another context, Campo Baeza says that architecture without an idea is an empty architecture.[13] The uselessness of architecture is something that architects have almost always tried to avoid, realizing that functionality or use are issues that make any building necessary to be the guarantee of its permanence and continuity over time. If this is a pertinent issue in this equipment, as there have been some discontinuities in its operation, the truth is that this building can and should anchor the supply and sustainability of Montemor Castle.

The Tea House, being a bold proposal for that context, has as a strong point its abstracting aspect that places it outside the surrounding scenario but simultaneously, generates enormous empathy with the place and concurrently a strong adhesion by the users. The almost complete transparency of the "box", assisted by a design of inestimable rigor, functions as an aggregator element of the fragmentary walls of the ruin, helping to define a volume, apparently without load, without weight and practically without expression, but which induces a conceptual tension that refers to a certain essentialization of architecture. This work, of simple appearance but with a powerful image, for its scale, its detail, its intrinsic quality, constitutes a "little jewel" of Portuguese architecture of the XX century.[14]

Somehow, the suspension of the Tea House over the ruin may denote some shyness or lack of courage to anchor the project to the site, but it is precisely this fulminating gesture that allows a delicate adjustment of a construction marked by the stone materiality of the existing one. In this way the new architecture does not impose itself on the existing one, rather it creates an unusual sensation of lightness that appears to have fluidity of space. As it floats in defiance of gravity, always ready to allow us to take flight and put our sight on the surrounding landscape. This work, which in some aspects reaches an almost objectual status, presents unique experimental characteristics, functioning as a resonance box of relational nature between existing space and proposed space. Using some artifacts and resources usually attached to the scenography, it induces the spectators to a haunting beauty, achieved under the basis that with a minimum of effects and elements one can maximize the aesthetic and contemplative sensations.[15]

Figure 12. Terrace and main entrance to the Tea House with a view of the surrounding fields. Photo by João Mendes Ribeiro

Paradoxically, that box that gently rests inside the ruins of the "Paço das Infantas" has been assuming itself as a work that has become part of all that surrounding space. Gradually, it has assumed itself as a building that harmonizes with the place, leading almost to suppose that it has always been there.[16] In fact, we are dealing with a poetic and highly sensitive work. Therefore, it would be particularly painful today to imagine that space, that place and that context without this remarkable work, distinct and architectonically unavoidable. ■

12 Ribeiro, João Mendes, "Casa de Chá" in *João Mendes Ribeiro Arquitecto*, p. 97.
13 Campo Baeza, Alberto, *A ideia construída*, Caleidoscópio, Casal de Cambra, 2004, p. 35.
14 Tostões, Ana, "Neutro e excepcional ou o esplendor da verdade" in *João Mendes Ribeiro Arquitecto*, p. 10.
15 Rodeia, João Mendes, "Línea de tierra: presentación de una nueva generación de arquitectos portugueses", *2G – Revista Internacional de Arquitectura*, nº 20, 2001, p. 16.
16 Zumthor, Peter, *Atmosferas*, Editorial Gustavo Gili, Barcelona, 2006, p. 65.

Dr. Ângelo B. César Machado
CIN Administrator

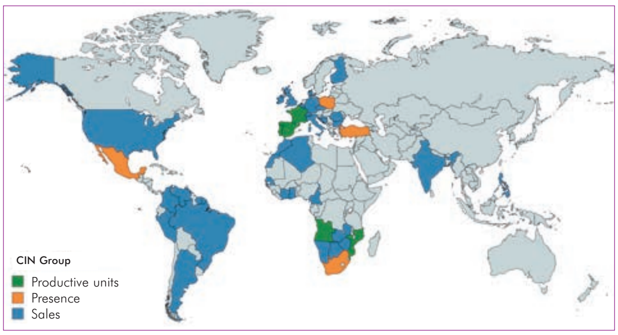
Challenges and Opportunities of CIN Internationalization

CIN, and in particular the Protective Coatings Division, has always had an international vocation. This intention is easy to understand if we take into account that the CIN began to leave the continental territory in 1970 with the creation of CIN Angola, a journey that has been made for almost 50 years. Since then the process has been continuous, and still in the decade of the 70's of the last century, we created CIN Mozambique.

At the end of the twentieth century the process of growth continued in an accelerated manner, with the purchase of four companies aiming for growth in the Spanish market, which together with the leading position in Portugal, made CIN the Iberian leader since 1995.

With the beginning of the twenty-first century, the internationalization process was no longer just a voluntary option, and it became a challenge that needed to be answered in order to continue future growth, particularly in the area of Protective Coatings.

Since 2000, CIN has further extended its work area, entering the French market with the acquisition of 2 companies, and more recently with the opening of commercial subsidiaries in the scope of anticorrosive and industrial paints in Mexico, South Africa, Turkey and Poland.



In addition to the countries where we have our own production, R&D or commercial operations, CIN is present in 31 other countries around the world, through agreements with other manufacturers, representatives or distributors.

The global presence in the Protective Coatings business is essential. Increasingly, construction projects have players from different nationalities. The owner, the project engineers or the construction companies can be thousands of kilometers away, and there are many cases in which the construction and painting of the steel structures is done in a country or area of the world that is very far from the site of implantation of the contruction works.

This process of globalization of the market is one of the reasons why internationalization is no longer an option, to become an unavoidable necessity for companies in this sector that want to have a future with sustained growth. In fact, this movement that pushes companies to go to other countries often ends up giving rise to a whole world of discoveries and opportunities for growth in new markets.

One of the main challenges in the internationalization process was, and continues to be for us and I believe that for most companies, the integration of different cultures, ways of living and communicating within the mother company. It is a process that requires effort in both directions, both for the national collaborators who have to get used to new realities, as well as for the new collaborators who integrate the company with their own habits and routines.

The key to success in the internationalization process is to have a long-term vision and commitment from top management, which we have always had at CIN. This process is never easy and requires "high doses of patience" and perseverance, because almost always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the results take longer than expected in the companies' Strategic Plans.

The focus on internationalization is a source of opportunities and once it has a considerable dimension it is self-sustaining and a source of growth in several areas. The discovery of new markets and opportunities means that products that sometimes do not reach their full potential in the country of origin will gain very significant growth even for purposes that were not initially foreseen.

Another of the great gains of internationalization lies in the sharing of knowledge and experiences of more and more markets. This situation, although introducing greater complexity in the collection of information and its processing and evaluation, greatly enriches the process of developing new products in terms of R&D.

CIN has always wanted to be owner of its future and to have a continuous and sustained growth. Internationalization, particularly in the area of Protective Coatings, is one of the means to gain the dimension and capacity to effectively own our future. ■

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distortion of welded structures

Deformations caused by welding are as trivial as difficult to control, but very detrimental to the quality of the structures. This damage extends from merely aesthetic aspects to functional aspects that interfere with the assembly of the structures. The theoretical principles that govern the emergence of deformations, commonly referred to as distortion, and the appearance of residual stresses, a theme already presented in a previous article [1], are closely related and easy to understand, but the deformations are difficult to estimate with accuracy. To explain the phenomenon quickly, the analogy shown in Figure 1 is used. The part shown in Figure 1 a) represents a free bar at 20 °C which, when heated to 800 °C, widens from the length l0 to l0+Dl and also expands in cross-section. When the part cools uniformly to the initial temperature it will shrink to the initial dimension. If the bar is initially between fixed walls at 20 °C, when heated to 800 °C it will expand in the cross section, but not in length as it is impeded. However, upon cooling the bar will be shorter in length, also varying the section. In practice, when welding a part, it is heated only locally which causes the remaining material that has remained cool to oppose the expansions and contractions, leading to the distortion of the part.

Such deformations may be longitudinal, transverse, angular, or other resulting from the combination of the foregoing, such as rotational or buckling. These deformations are illustrated in Figure 2 [2,3]. The latter and the angular distortions are the most visible, but the rest are equally pernicious. The exact prediction of these deformations is however very difficult, especially in the case of complex geometry structures, since it depends on many variables, associated with the physical properties of the materials, the welding process, the induced thermal history, the welding procedure adopted and the geometry of the joint. The finite element method is used in the prediction of simple cases [4], however it is often difficult to accurately reproduce the manufacturing conditions used.

There are sometimes in the literature some values of deformations for the simplest cases, all of them based only on experience. For transverse shrinkage, values in the order of 0.8 mm for fillet welds are indicated when the weld foot does not exceed ¾ of the thickness of the sheet and 1.5 to 3 mm for the butt welds with chamfer angle at 600, increasing the shrinkage with the number of weld layers [5]. For longitudinal shrinkage, the same authors indicate values of 0.8 mm for every 3

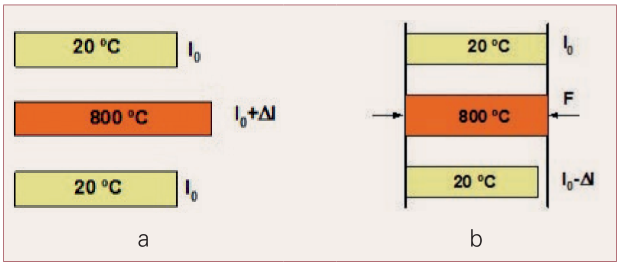

Figure 1. *a) Free part; b) Limited part between rigid walls.*

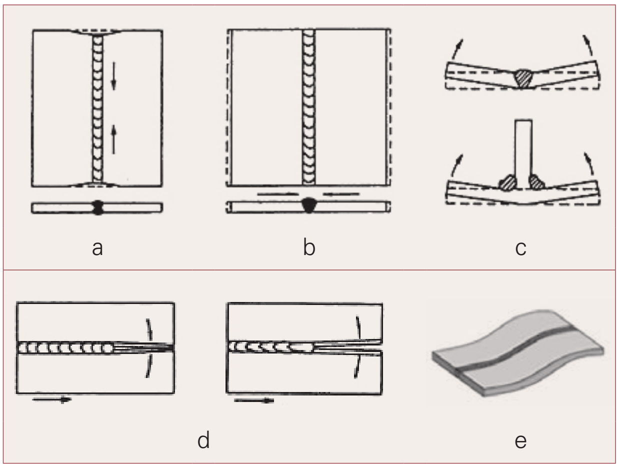

Figure 2. Weld deformations [2]: *a) Longitudinal shrinkage; b) Transverse shrinkage; c) Angular distortion; d) Rotational distortion; e) Buckling distortion* [3].

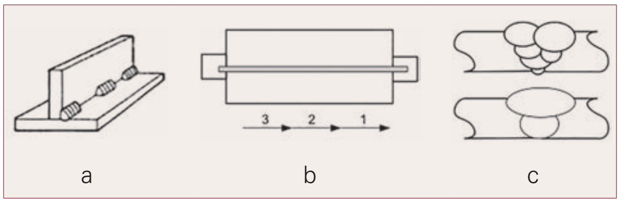

Figure 3. *a) Intermittent welding [6]; b) Pilgrim pitch welding; c) Reduction of the number of layers to reduce deformation.*

meters for fillet welds and 3 mm for every 3 m for the butt welds.

As these deformations are inevitable the question that arises is how they can be minimized. Minimization can be done in the design phase and in the execution phase of the welds. In the technical literature a wide range of recommendations is mentioned to minimize the deformations, of which I mention only the most important [6]. Reduce the volume of welding and the amount of heat input only to what is strictly necessary, which reduces not only deformations but also saves on the workforce. The preparation of X-joints instead of V mainly for the higher thicknesses (over 16 mm) has the same effect, provided that the welding is performed alternately on either side of the plates.

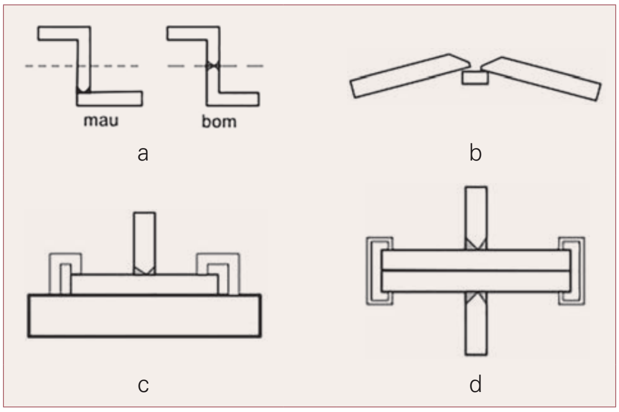

Figure 4. *a) Welding placed next to the neutral axis of the structure; b) Introduction in the pieces of previous deformation contrary to the deformation of welding; c) Fixing the parts to a rigid support; d) Joint attachment of two pieces.*

If possible, use intermittent welding instead of continuous welding to reduce heat input and heating, as shown in Figure 3 (a). If continuous welding is required, use the pilgrim pitch technique shown in Figure 3 (b). The welding in smaller segments and in which when each segment ends will find the anterior segment almost cold causes less heating of the part and therefore less distortion. When there is a risk of major deformation in the structure it is better to perform the welding in less layers, as shown in Figure 3 c), since the deformation is cumulative, ie deformations are added layer after layer.

The welds shall be placed close to the neutral axis of the parts in order to minimize strain induced by the stresses created, as shown in 4 (a). Another solution can be the introduction in the parts of deformation in the opposite direction to the deformation predicted, according to Figure 4 b). Another alternative is to fix the part to a rigid support, according to Figure 4 c), and only remove the fixation after the complete cooling of the part. When possible, the parts can be fixed each other by backs, in order to increase the rigidity of the assembly during welding, see Figure 4 d).

Regardless of the techniques reported above, the higher the induced heat input in the structures, the greater the level of deformation caused, so that more efficient welding processes induce lower deformations. In the industrial application a careful forecast of the deformations that can occur in a welded structure is not often done, reason why its later correction becomes necessary. It should be noted that corrective actions are time-consuming and costly and can lead to degradation of steel properties. Basically the corrections can be made by cold plastic deformation or by hot deformation.

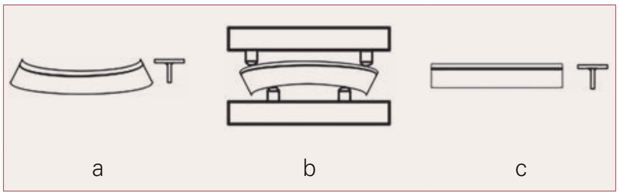

Figure 5. Straightening of welded structure. *a) Structure with distortion; B) Cold-straightening; C) Straightened structure.*

Corrections for cold plastic deformation can be carried out by hammering or by plastic deformation in press. However, EN 1090-2 [8] does not allow hammering to be used. This second technique is the most recommended because it allows better control of the induced plastic deformation. This technique consists in inducing in the cold plastic forming part in the direction opposite to the initial deformation, as shown in Figure 5. This deformation must be of a higher value than the existing one, in order to compensate the elastic return, as shown in Figure 5. Removal of the buckle should be done in a progressive manner, so as not to induce a deformation accumulated in the structure beyond that corresponding to the tensile strength of the material, which would lead to heterogeneous plastic deformation of the material, with consequent location of the deformation. These corrections imply high loads, which requires special care with safety of operation [7]. Cold straightening leads to increased strength of the

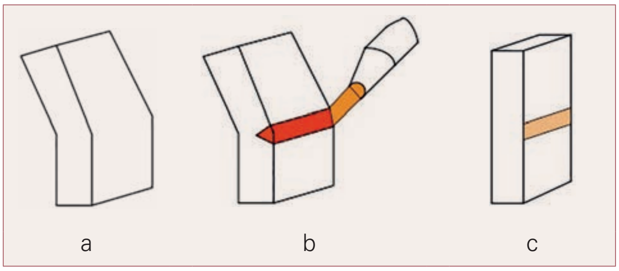

Figure 6. Straightening of welded structure. *a) Structure with distortion; b) Hot-straightening; c) Straightened structure.*

structure material, but also to its loss of ductility and toughness, which is undesirable.

The hot correction of the deformations uses the local heating of the material to cause its plastic deformation, due to the installed stresses, the lowering of the elasticity limit of the steel with the temperature and the surrounding material that remains cold, followed by more or less abrupt cooling, which tends to shrink the zone smaller than the initial size, as shown in Figure 6. This heating can be point heating, in line heating or in general, according to the geometry of the zones to be performed. Reference [7] gives some more detail about the procedures to be adopted, usually based on experience.

The hot straightening shall be performed at a temperature below 650 ° C in the case of structural steel in order to reduce the metallurgical changes and the mechanical properties of the steel. Standard EN 1090-2, for structures classified in execution classes 3 and 4 (EXC3 and EXC4), requires the qualification of the hot straightening procedure where the mechanical properties of the steel are demonstrated after straightening. ■

References

[1] Altino J. R. Loureiro, origens e efeitos das tensões residuais em estruturas metálicas soldadas, Metálica, vol. 44 (2016), 28-31.

[2] http://www.kobelco-welding.jp/education-center/abc/ABC_2006-03.html

[3] http://www.m2i.nl/portfolio-items/angular-distortion-and-buckling-in-welded-plate-damen-schelde/

[4] http://ir.library.osaka-u.ac.jp/dspace/bitstream/11094/10426/1/jwri38_02_063.pdf

[5] http://www.twi-global.com/technical-knowledge/job-knowledge/distortion-types-and-causes-033/

[6] http://www.lincolnelectric.com/en-us/support/welding-how-to/Pages/weld-distortion-detail.aspx

[7] http://www.twi-global.com/technical-knowledge/job-knowledge/distortion-corrective-techniques-037/

[8] EN 1090-2 – Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures.

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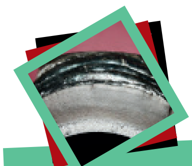

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The Significant Advances of Wind Energy and the New Trends for the Steel Structures Market in Brazil

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1. Introduction

Currently, the world scientific community is constantly searching for environmentally sustainable solutions, based on a process of awareness about global warming experienced by the planet since the last decade, generating concrete initiatives that seek new options and the use of renewable sources of energy ("clean" energy), such as wind energy. Countries such as China and the United States of America stand out in the global scenario due to their high degree of investments in renewable energy sources, when compared to the other countries in world scale [1]. There are reports that the earliest attempts to generate electricity using renewable sources of wind energy took place in the late nineteenth century. However, significant investments for its viability were only made a century later, after the world oil crisis in the 1970s, with indications of the first commercial wind turbine connected to the public electricity network installed in Denmark in 1976 [2].

It is known that major and special concerns about environmental issues became more relevant after the events of 1979 and 1986 due to nuclear accidents at the "*Three Mile Island*" reactors (United States of America) and in the city of Chernobyl (former Soviet Union), respectively. After these accidents, a great discussion began on the subject in question, as well as on the application of investments and research on the study of renewable energies, especially with regard to wind energy [3].

In this sense, it should be emphasized that wind energy is the kinetic energy that exists in wind currents (masses of moving air) that is normally converted into mechanical energy by windmills or into electric energy by wind turbines (or air generators) [4]. One of the world's largest wind potential is in Brazil, however, its high production cost is still an obstacle to be overcome, because the energy generated costs between 60% and 70% more than the same amount generated by a hydroelectric power plant [5]. Some countries have established financial incentives to stimulate the increase of wind power generation by reducing its high cost of production, being a widely available and renewable energy source [6].

The latest report from the World Wind Energy Association (WWEA) [7] shows that the top five countries in the ranking hold 67% of the total amount of the installed world capacity and that Brazil grew 106% in 24 months. The Global Wind Energy Council [8] (GWEC) has published a Global Accumulated Capacity chart from 2001 to 2016, which shows that total installed capacity of world wind energy has doubled in five years (2011 to 2016), as shown in Figure 1. Germany, until 2005, was the leader in wind energy generation, but was overtaken by the USA in 2008,

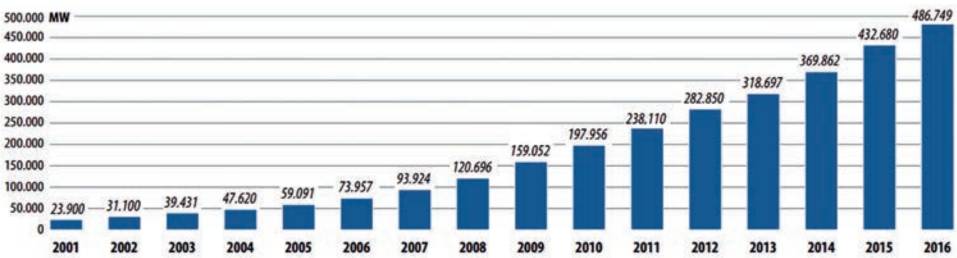

Figure 1. World Wind Energy (2001-2016): global accumulated capacity.
Source: World Wind Energy Association [7] (WWEA).

which lost its leadership to China in 2010 [6], currently owning the installed total of 168.69 GW, more than double the second ranked US (82.18 GW) [8].

Brazil still has its electrical matrix based on large hydroelectric plants, responsible for more than half of the Brazilian energy matrix. However, there is no longer room for developing large hydroelectric projects in the country due to environmental issues. Thus, in search of new renewable energy solutions, wind energy has played a key role in Brazil's energy development, as an option of low environmental impact, rapid implementation and emission of zero CO2, helping the country to meet the reduction targets of CO2 released into the atmosphere. Currently, installed wind energy represents 7% of Brazil's energy matrix, with a target of reaching 12% in 2020 and 20% -25% by 2030 [9].

2. The technological advances of wind energy in Brazil

The study of the technical capacity to implement wind turbines in Brazil began in the early 1990s [2] based on the installation of the first computerized anemographs and special sensors for wind energy in the state of Ceará and in the island of Fernando de Noronha, with the objective to determine the site's wind potential for the future installation of wind turbines. According to Grubb [10], the wind speed at a height of 50 m should be at least 7 to 8 m/s (with a density greater than 500 W/m²) for wind energy to be considered technically usable. Considering the study worldwide, only 13% of the land surface reaches a value of 7 m/s, at a height of 50 m, according to the World Meteorological Organization [2].

In this sense, Brazil presents good wind currents, of good quality, with one of the highest coefficients of wind energy generation in the world [9], which represents the efficiency measure of the wind turbines of a wind site based on the quality of the wind of the location of the equipment installation. This factor is measured by the average time that wind turbines take to generate energy.

It should be emphasized that the winds that present the greatest possibilities for the production of wind energy are those that have constant speed or direction, without major changes [9]. In the Northeast region this capacity

Figure 2. Wind power plant in Morro do Camelinho (Gouveia/MG) [11]. Source: Dissemination CEMIG/MG.

factor is higher than 50%, well above the world average that is around 20 to 25%, attributing the significant title to the country as *"Brazil one of the best winds in the world"* [9].

In 1992, on the island of Fernando de Noronha/PE, the first wind turbine of Brazil was installed, based on the use of an asynchronous generator of 75 kW, as shown in Figure 2, from the project carried out by the Group of Wind Energy of the Federal University of Pernambuco (UFPE), with funding from the *Folkecenter* (Danish research institute), in partnership with Energy Company of Pernambuco (CELPE/PE). The turbine in question provided a relevant economy at the time of about 70 thousand liters of diesel per year, equivalent to 10% of all the energy consumed by the island in the same period [2]

In the city of Gouveia/MG, the first wind power plant in Brazil was installed in Morro do Camelinho in 1994, according to Figure 3, with a nominal capacity of 1MW (4 turbines of 250 kW), with the financial support of the German government (Eldorado Program), together with the Energy Company of Minas Gerais (CEMIG/MG) [2]. Then, the Prainha Wind Power Plant (Aquiraz, CE), as shown in Figure 4, and the Palmas Wind Power Station (Palmas/PR) were inaugurated in 1999, as shown in Figure 5, which is the largest wind site in the country with a capacity of 10 MW (20 turbines of 500 kW); and also the first wind power plant in the southern

Figure 3. Wind power plant in Prainha (Aquiraz/CE) [12]. Source: Blog Cristiano Couto.

region of Brazil, with a capacity of 2.5 MW (5 turbines of 500 kW), respectively [2]. The island of Fernando de Noronha/PE received its second turbine in May 2000, generating around 25% of all the energy needed for the island [2]

In the early 2000s, a major drought in Brazil reduced the water level in the country's hydroelectric dams, causing a severe energy shortage that devastated the economy and led to a severe rationing of electricity. Therefore, in view of the nation's urgent need to diversify its energy sources, in 2002, Brazil created the Program for the Incentive of Alternative Energy Sources (PROINFA) [14] to encourage the use of other renewable sources, such as wind energy, biomass and Small Hydroelectric Plants (SHPs). It is also worth noting that the first auction for the commercialization of wind energy in Brazil was carried out in 2009, in a growing movement to diversify the energy matrix.

Figure 4. Wind power plant in Palmas (Palmas/PR) [13]. Source: Copel.

We also emphasize that Brazil is accelerating the development and implementation of new wind sites, considerably improving its position in the world wind energy ranking, jumping five positions in relation to energy production using the wind, with an increase of installed energy generation capacity in 2016, of about 55% [15]. Currently, the country occupies the first position in Latin America and ninth position, worldwide, based on installed wind capacity of about 10.79 GW, and its share (wind energy) in the Brazilian energy matrix has reached a percentage index of 7.1%, as illustrated in Figure 6 [16]. The state of Rio Grande do Norte/RN remains the largest producer of wind energy in Brazil. In 2016, the state's plants produced 1,206 MW. The Potiguares projects also add up the largest installed capacity, totaling around 3,181 MW [15].

3. Using steel in the wind turbine structure

In general, the structural system of a wind tower is divided between tower, blades, rotor hub, axis nacelle, generator and, depending on the technology used in the design, gearbox, being the majority of these elements

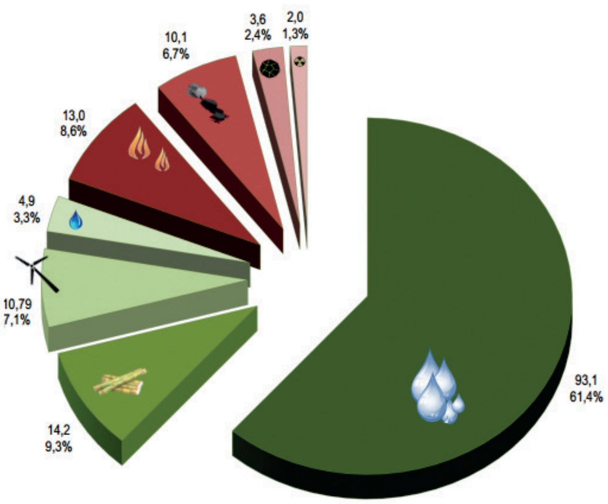

Figure 5. Brazilian energy matrix [16]. Source: ABEEólica.

made of steel. In particular the towers, structural systems responsible for the support and positioning of the wind group, can be of conical or lattice type, being built from different materials [17].

The lattice towers use galvanized steel and the conics can be in laminated steel and prestressed concrete or hybrid (composite) conics, with their lower part in

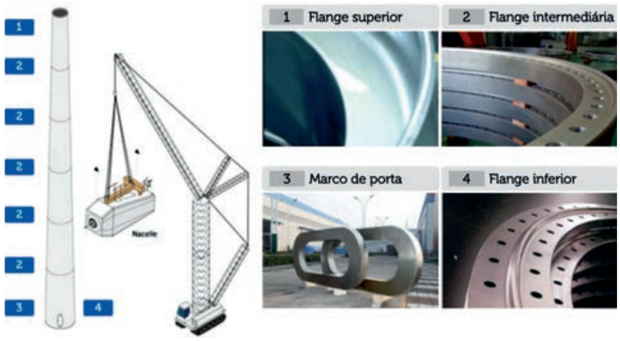

Figure 6. Conical steel towers: forged components [19]. Source: Grupo Iraeta.

reinforced concrete and the upper part in steel. The definition of tower type and material depends on several factors, such as cost, wind turbine height, ease of transportation, assembly and maintenance. In wind sites installed in Brazil, conical steel towers are more common due to their height range, with an approximate weight of between 100 and 200 tons (depending on the height of the tower) and composed of 98% of steel [18],. Figure 7 below shows the forged components of the structural system of the conical steel towers and Figure 8 shows the internal steel components of a wind tower.

Figure 7. Conical steel towers: internal view of the structural system [20]. Source: Hailo.

Regarding the use of steel in the structural design of wind towers, it should be pointed out that, currently, the percentage of steel used in the entire structure of the wind turbines is of about 89% [18], already considered a high value. However, this index may increase, as researchers at the Fraunhofer *Institute for Machine Tools and Forming Technology* (IWU I) in Chemnitz, Germany, and at the Free University of Brussels (VUB) [21] are investigating the substitution of the plastic material that compose the blades, due to the poor possibility of recycling the material, with steel blades, which offer numerous advantages such as recycling of the material and more accurate and faster manufacturing. The main cause of this difference lies in the manufacturing process, since the fiber reinforced plastic blades require manual mold treatment and more time for curing. On the other hand, steel blades can be produced quickly, with processes similar to those of the automotive industry.

4. The trend of the steel structures market in Brazil

Going against the crisis that Brazil has faced in recent years in the industrial sector, with reduced investments in all spheres of the economy, the wind energy sector continues to grow and with great potential to reach 2020 with an installed capacity of about 17.28 GW [16], as shown in Figure 9. In 2012, this growth factor caught the attention of the leader the long steel segment in the Americas (GERDAU), with more than 45,000 employees and industrial operations in 14 countries (Americas, Europe and Asia), to develop a new product for the wind energy generation sector, the 42CrMo4 modified steel, specially created for the production of fasteners for wind turbine towers, meeting the high level of demand, with low cost, so as to obtain a product produced in Brazil with domestic raw material, facing the other options of products found in the international market.

It should be pointed out that in 2016, the Administrative Council for Economic Defense (CADE) in Brazil approved, without restrictions, the *Joint Venture* formed by GERDAU and the Japanese companies *Sumitomo Corporation* and *The Japan Steel Works*, with extensive knowledge of the world wind energy market and technological domain of the components production process for this sector, continuing the great interest of GERDAU in the direction of investment in wind energy and confirming an ambitious timetable for the implementation of the project announced in January of the same year, that is: from the end of 2017 GERDAU will start supplying forged parts for wind energy generation towers and cylinders for the steel and

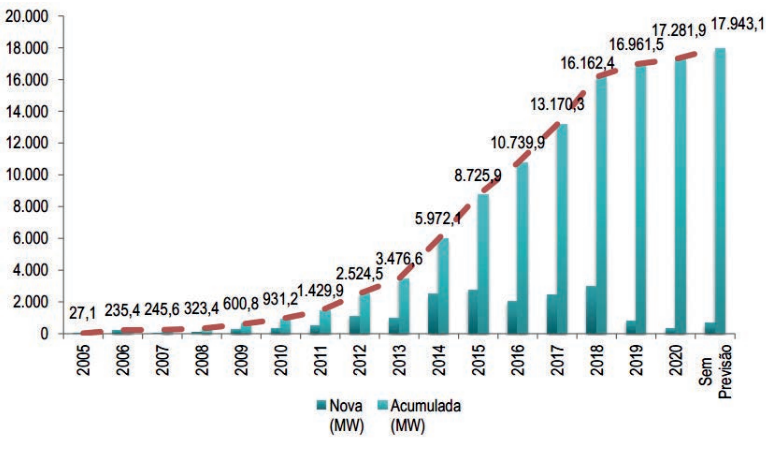

Figure 8. Evolution of the installed capacity in Brasil [16]. Source: ABEEólica.

aluminum industry, with total parts capacity for the wind industry and cylinders of 50 thousand tons per year [22]. The investment for the acquisition of new equipment by the *Joint Venture* revolves around R $ 280 million and will supply forged steels for the production of the main axis the bearings of the blade and the bearing of the wind towers [22].

The scenario of the wind industry in Brazil is very promising for the steel structures segment, due to the good conditions of installation of wind turbines and constant winds in the South and Northeast regions of the country. Based on data from the Brazilian Wind Energy Association, there is a forecast to build 330 wind sites by 2020 in Brazil, jumping from the current 7% installed wind capacity to more significant percentage ratios, ranging from 11% to 12% % of share in the nation's energy matrix [22].

5. Final considerations

This technical article has as main objective the approach of a positive and very promising trend of the Brazilian market of steel structures within the energy sector, based on a recent search for environmentally sustainable solutions of "clean" electric energy, such as, wind energy. It is noteworthy that wind energy has doubled its installed capacity globally speaking, in less than five years, from 2011 to 2016. Following the developed countries, such as China, the United States of America and Germany, Brazil proved to be a great investor in the sector, mainly after the auctions of commercialization of energy directed exclusively to wind energy in 2009, increasing the numbers associated with the generation of wind energy and including Brazil in the ranking of the 10 countries with the largest installed capacity worldwide. In order to meet this demand, the leader in the long steel segment in the Americas and one of the main suppliers of special steels in the world (GERDAU) has started a partnership with the Japanese companies *Sumitomo Corporation* and *The Japan Steel Works*, in order to compete strongly in this national market of wind energy and also, with the products of the international market, that "reigned solitarily" until very recently. In this context, which is very relevant for Brazil, the use of steel in the structural design of wind towers has been preponderant, since the amount of steel used in the entire structure of wind turbines is of about 89%. ■

6. References

[1] Dellezzopolles Junior, CF. "Análise Dinâmica de Torres de Energia Eólica", Dissertação de Mestrado, Universidade de Brasília (UNB), Brasília/DF, Brasil, 2011.

[2] ANEEL (Agência Nacional de Energia Elétrica). "Atlas de Energia Elétrica do Brasil". 2ª Edição, Brasília/DF, Brasil, 2005.

[3] Available at: http://www.proceedings.scielo.br/scielo.php?pid=MSC0000000022002000 100002&script=sci_arttext. Access in: March, 2017.

[4] Available at: http://www.ecycle.com.br/component/content/article/69-energia/2899-o-que-e-energia-eolica-entenda-como-funciona-turbinas-geram-eletricidade-ventos-vantagens-desvantagens-usina-parque-renovavel-limpa.html. Access in: March, 2017.

[5] Available at: https://www.significados.com.br/energia-eolica/. Access in: March, 2017.

[6] Available at: https://evolucaoenergiaeolica.wordpress.com/energia-eolica-no-mundo/. Access in: March, 2017.

[7] Available at: http://www.wwindea.org/wwea-half-year-report-worldwind-wind-capacity-reached-456-gw/. Access in: March, 2017.

[8] Available at: http://www.gwec.net/wp-content/uploads/vip/GWEC_PRstats2016_EN_ WEB.pdf. Access in: March, 2017.

[9] Available at: http://www.abeeolica.org.br/noticias/dez-fatos-sobre-energia-eolica-brasileira-que-voce-talvez-nao-saiba/. Access in: March, 2017.

[10] Grubb, MJ; Meyer, NI. "Wind energy: resources, systems and regional strategies". In: Johansson, T. B. et. al. "Renewable energy: sources for fuels and electricity". Washington, D.C.: Island Press, C. 3, 1993.

[11] Available at: http://www.cemig.com.br/sites/Imprensa/pt-br/fotos/Paginas/usinas_eolicas .aspx. Access in: March, 2017.

[12] Available at: http://cristianoscouto.blogspot.com.br/2009/12/usina-eolica-da-prainha-aquiraz-ce.html. Access in: March, 2017.

[13] Available at: http://www.copel.com/hpcopel/root/nivel2.jsp?endereco=%2Fhpcopel%2 Froot%2Fpagcopel2.nsf%2Fdocs%2FC61E3512CB91AF04032574A20048D3A3. Access in: March, 2017.

[14] Available at: https://evolucaoenergiaeolica.wordpress.com/energia-eolica-no-brasil/. Access in: March, 2017.

[15] Available at: https://www.petronoticias.com.br/archives/95220. Access in: March, 2017.

[16] Available at: http://www.abeeolica.org.br/wp-content/uploads/2017/02/Dados-Mensais-ABEEolica-02.2017.pdf. Access in: March, 2017.

[17] Custódio, R. Energia Eólica. 2ª Edição. Rio de Janeiro: Synergia, 2013.

[18] ABDI (Agência Brasileira de Desenvolvimento Industrial). "Mapeamento da Cadeia Produtiva da Indústria Eólica no Brasil". 2014.

[19] Available at: http://www.grupoiraeta.com/products.php?opc=windtowersector. Access in: March, 2017.

[20] Available at: http://www.hailo-professional.de/prof_public/products.php?b=6. Acesso em: março, 2017.

[21] Available at: http://www.abcem.org.br/noticias-ver.php?cod=4278. Access in: March, 2017.

[22] Available at: http://noticiasmineracao.mining.com/2016/11/28/gerdau-inicia-a-producao-de-pecas-para-industria-eolica-em-2017/. Access in: March, 2017.

Ronald Schleurholts

Amsterdam Temporary Courthouse

Amsterdam Temporary Courthouse is a building that will only stay for five years. The architect Ronald Schleurholts explains why it was the perfect assignment, and how his office has used the brief to further their design principles.

Interview by Lasse Kilvær
Norwegian Steel Association

How did the project begin?

I think the Design, Build, Maintain & Remove (DBMR)-assignment is the main starting point. The courthouse is temporary because most of the existing courthouse will be demolished and rebuilt. The government asked for a solution where they will keep a small part of the courthouse in function, a monumental part from the 60's, while they are demolishing and building the new one. But you lose a lot of the functions when you demolish three quarters of the courthouse. Our assignment was to design a temporary building that would be connected to the remaining part of the court house, and demolished when the new courthouse is complete after 5-7 years. The building that is being demolished is quite a young building. To be sustainable, the government specified that the new building must not be a waste of material, energy, or funds.

The competition is a design-build competition, so we had to team up with a builder. The other entrants were all the big building contractors, while we made a joint venture with a smaller contractor, so we entered the competition as an architect-led building team. In a sense we were the dark horse of the competition, but we have a lot of experience with demountable structures.

We had to be accountable for the material over the whole lifespan. Hollow core concrete slabs have a lifespan of 50+ years, what will it become of them after this first 5 years? The trick was to make a very flexible kit of parts, where we minimize the materials, and can be responsible for their quality. The first idea was to use reused materials in the building, to cut out second hand hollow core concrete slabs from an existing 90's building, make them demountable, and apply them in our building. That way we would have had about half the lifespan under control. However, it is more important to make the building function as a kit of parts, because then you can get good quality materials and make sure they are reusable.

Who will demolish the building?

The same contractor that built it. That is a good reason to do it like this. If you build for yourself, nad you have the responsibility for what happens with it next, it is worthwhile to invest in quality materials. A standard developer will always build a building as cheap as possible, because he writes the whole building off financially in 10-15 years. But if it is your material, and you have responsibility for maintenance and removal, and you want to reuse it, you might think differently.

So the contractor owns it now, the government is just using it for 5-7 years. The contractor is the owner of the building, and will have to maintain, demolish and reuse it. That was very useful when they functioned as our clients, we could argue for certain choices that may cost a bit more but makes economic sense in the long run.

Have you found the next role of the building?

Five years is very short in building terms, it is almost tomorrow. We have a spot in Leiden, an area for new industrial buildings. We found an owner of that land that wants to have it rebuilt it here. So that's a backup, but there's a lot of interest, for instance there is a courthouse in Den Haag that will be renovated in a few years, and they will need a temporarary solution there, so it could be that it will stay a courthouse, but in another city. If it goes to Leiden it will be an office building.

The main thing is that is adaptable, demountable, and with very cost efficient materials. It should not be expensive, it is only temporary. On the other hand, it is a courthouse, not a startup. It should be precise and with the quality to represent the judiciary system in Holland. It cannot look too temporary, it's an important building. It needs to be very flexible but still feel nice to be in, to have a humaneness, because people will already be stressed when they arrive.

Will everything be reused?

The core of the building, the structure, the façade, the stairs, bridge, the ceilings and entrance are all very flexible and demountable, but quite a lot of the interior is not. We went as far as possible, but we wanted to go further. Many of the requirements for the fit-out were so specific, that it was difficult to make it standardized.

How does the designing for disassembly affect the design overall and the architectural language?

Our office started in the 70s, and from the very beginning, we have designed all our buildings as kit of parts, with no welding on site etc. As such, the brief was made for us. We have done this for 40 years.

What is the trick of designing for disassembly?

Step one is looking for standardization, for the common denominator, in floor heights etc, and trying to have a very clear plan. Step two is focus on the connections between the elements; that they are flexible, that there is enough tolerance, to mount and demount. But we don't want to show it too much, with bolts etc.

In the beginning, we made all the floor heights the same, because it would make it more flexible in its second life, but had to abandon it during the design stage, partly because of the cost, but mainly because we had to take into account the height of the original courthouse, that it would be connect to via a bridge. You always have to find a balance.

You employed some novel technical solutions. Would you tell the story of the hollow core slab-joints?

It is the by far the most easy and cost effective flooring, but you always connect it in the same way- by pouring concrete on top. They are always assembled wet, which is not a clean connection, and makes it difficult to reuse. We wanted to make it demountable. The first idea was to pour a new ending to the hollow core, and to add a steel connector, but that was not feasible. The production is done in special factories with an extrusion production line, and the concrete factory said it would not spend time on the extra work. It was not interesting for them. We decided to make the connections on site, by opening up the slots of the hollow core and adding a steel anchor, pouring it, but only within the panel itself to keep it apart from the loadbearing steel structure frame. There are two anchors, for vertical and horizontal fixations, in order to achieve the floor working as one stable plane.

Why have you chosen to not patent the solution?

Over the years, we have only sent two applications for patents on our innovations. No patent: One of the first was a very smart steel flooring system, but in the end we decided that it didn't help us, if someone wanted to use it they could just change the solution a little bit. Our core business is to make smart new buildings, and we develop new solutions for that, but maybe its just a compliment if someone else wants to use our solutions.

Usually we make very smart, new materials and interesting new production methods, whereas this joint is a very low-tech solution. We joke that it is a level of innovation suitable for the building industry. It's sturdy and quite easy to produce on site. We always strive for a prefabricated solution, but it would be very similar to the solution we have now.

What was the most interesting experiences you made in this project?

The façade is made up of cross-laminated prefabricated timber sandwiches, which can be strengthened with steel plating for security, or replaced with standardized glass panels. We proposed to use recycled plastic crane plates, which are used on buildings sites, thick plates that cranes and trucks drive over. We wanted to slide them into a nice stainless steel detail, and use them as the façade material. It would be cheap, low-tech, demountable, reusable, and recycled. The thing is, when we tested it during the preliminary design stage, it didn't work at all. It was too weak, it expanded too much when it got hot, and it got all wobbly when we fixed it on the wall. So we had to take a step back and think. The plates are 30 mm thick, and that's a lot of material. The very basics of sustainable building is to use less material, so we decided to go for the absolute minimum. We took a recycled seamless plastic textile that is only 1mm thick and spanned it between the glass panels, making it the outer skin of the building. It looks better than it would have with the plates, and imagine the amount of material we save. We ended up using almost the same fabric material as interior cladding of the balustrades, but in another color. When you demount the building, you can just roll it up and transport it. We always try to minimize the amount of kilograms, and to make it as smart as possible- we call it IQ per kilogram.

Another thing we did is to design fire escapes, the bridge, and the entrance hall as separate structures from the main square building. When the building is moved to another location, all of these elements can change position without altering the structure of the main building.

What type of buildings are right for this approach?

We try to do it with all our buildings, not because we think they will be moved, but because it gives a much better building quality when you prefabricate. With dry assembly, you can always demount it, but it also gives a great flexibility in use. Not many buildings will be completely demounted, but often parts will, such as the facades and the interiors. When you make flexible, demountable building, you get a much better building, even if it will be kept in the same spot, because it can adapt quite easily to different functions. For example, we had a drug research laboratory, which was changed into part of a university. We changed the entrance façade, and that was about it. We think it is wise to make buildings that are as prefabricated and flexible as possible. Even if a building lives for a hundred years, we do not build for eternity, and we are not trying to build monuments over ourselves. With dry assembly it will be easier to recycle, when the time comes.

Are you working on any other temporary projects now?

We are working on a new pier for the Schiphol Airport, and we also did a hospital two years ago, and these are buildings that we know are in constant change. It is easier to have all these changes if you design demountable buildings, like we do, and you can build faster. That was very important at an airport.

We are building a temporary pavilion next to a big design, build, maintenance and finance-project in Utrecht, meant to activate to urban area. A lot of what we learnt in the Amsterdam Temporary Courthouse is used in this project, and we actually went further. We reuse the smoked glass panels from the existing building as cladding for the pavilion, which is also completely flexible, demountable with reusable materials, ready for the growing circular economy. The pavilion will only live for 5-10 years.

We are also renovating an extension to heritage building office. It will be a steel structure, because you can work very efficient, refined and systematic with steel, but we will use a lightweight prefabricated timber floor system that is even more flexible than the concrete slabs we used in the courthouse.

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CMM 2017 technical training plan

CMM began its technical training plan under the general theme of steel and composite construction for 2017.

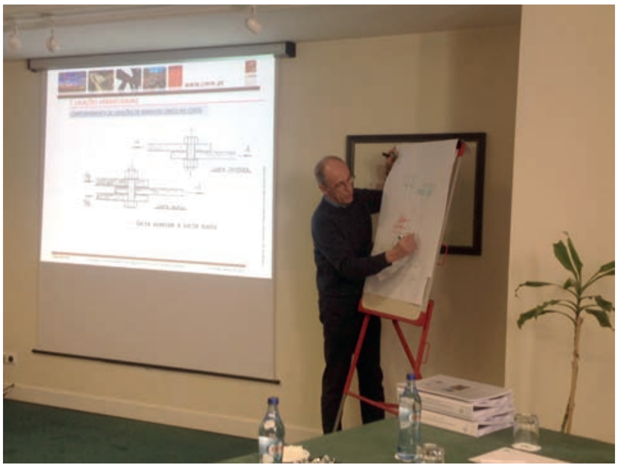

Figure 1. Tiago Abecasis, Talprojecto

The 2017 plan started with the 8^{th} edition of the Conception and Design of Connections in Steel and Composite Structures course, which took place on January 27 and 28 in Lisbon, and this course is based on the standard EN 1993-1-8, preparing graduates for the design of steel and composite connections.

At the end of the course the trainees should be able to conceive and design connections in steel and composite structures. The trainers of this course are Eng. Tiago Abecasis, also coordinator of the course, Professor Altino Loureiro, Professor Rui Simões, both from the University of Coimbra and Eng. Filipe Rodrigues. This course was attended by 16 trainees.

Figure 2. Conception and Design of Connections in Steel and Composite Structures course

This course was followed by the 9^{th} edition of **Design of Light Steel Framing Structures**, on February 24^{th} and 25^{th}, and once again sought to give the trainees knowledge regarding design of "light steel" structures and present in detail the standard EN 1993-1-3; Understand the calculation processes for designing structures in cold formed steel; Understand the most common problems associated with the construction of cold-formed steel from the point of view of a steelwork company. The course had as trainers Prof. Nuno Silvestre (coordinator and trainer) and Prof. Dinar Camotim, both from IST, Eng. Filipe Santos (Vesam) and Eng. António Santos (Gestedi). The course repeated the success of previous actions with about 30 trainees.

Figure 3. Design of Light Steel Framing Structures course

In this 1^{st} trimester, the course Design of Steel Structures – 4^{th} edition, was also held from March 16 to 18, with the purpose of presenting the standard EN 1993-1-1, preparing the trainees for the design of steel structures, and had as trainers, Eng. Tiago Abecasis, also coordinator of the course, Eng. Miguel Pontes and Prof. Nuno Silvestre from IST. The course had the participation of 19 trainees

See the CMM's training courses plan in **www.cmm.pt**

Steel Talk Portugal Steel at LNEC "Durability of Steel Constructions"

The Steel Talk, organized by CMM and LNEC - National Civil Engineering Laboratory, under the Portugal Steel project, was held on January 26 at the LNEC in Lisbon.
In order to respond to the increasing demand for steel construction solutions guaranteeing the quality, it is necessary to focus on innovation, which has been constantly evolving in recent years to meet the requirements of the market, which increasingly includes issues such as sustainable construction, Energy efficiency, green buildings, green and renewable energy. The steel construction reduces environmental impacts, it is versatile, 100% recyclable and in line with the concept of sustainable development. The challenge now presented is the durability of materials used in steel constructions, which directly influence the quality and sustainability of buildings.

For Professor Luís Simões da Silva, President of CMM *"Steel Construction has been increasingly included in projects related to green and renewable energy, projects increasingly considered as fundamental for Sustainability and the development of humanity. In this context, and since the durability of the materials will influence the sustainability of the projects, we consider it important to discuss the different techniques of protection against the elements, namely corrosion, either with steel coating or paint."*

"Steel construction accounts for 2.4% of national exports and represents 2% of the national GDP and it was only possible to achieve these values thanks to the high quality of our materials, which has undergone a decisive technological evolution and offers a wide range of materials, such as structural steels and aluminum alloys of high resistance to atmospheric corrosion and which ensure durability. However, the fear of corrosion sometimes gives rise to issues related to the durability of the materials used. This conference intends to demystify these themes and will discuss the methods and techniques that have been developed and will contribute to the durability of the steel constructions and to the continuity of the affirmation of this sector in the world panorama", reinforces the responsible.

Steel Talks are a set of conferences promoted under the Portugal Steel project, registered trademark of CMM, and are directed to all stakeholders and professionals in the sector, with a broad view of the same and subject to specific topics of discussion. For the year 2017 we will carry out and promote this type of actions, along with a series of other actions within the scope of this project.

Opening session, Luis Figueiredo Silva from CMM, José Manuel Catarino from LNEC and António Baptista from LNEC (from left to right)

Auditorium

António Baptista from LNEC

The 2017 Portugal Steel Seminar cycle is already scheduled:

– Faculty of Sciences and Technology of the University of Coimbra, Department of Mechanical Engineering, April 26, 2017
– Instituto Superior Técnico, Civil Engineering Building, May 8, 2017
– Faculty of Engineering of the University of Porto, Department of Mechanical Engineering, 03 October 2017
– Faculty of Sciences and Technology of the Universidade Nova de Lisboa, Dep. Civil Engineering, October 11, 2017

Consult the other project activities at www.portugalsteel.com

XI Conference on Steel and Composite Construction

In the year of the 20th anniversary, CMM - Portuguese Steelwork Association promotes the **XI Conference on Steel and Composite Construction.** The conference will take place on 23 and 24 November 2017, at Coimbra iParque, and will be dedicated to the special theme "The new generation of eurocodes."

The Conference follows the success of the previous editions of the Conference on Steel and Composite Construction and responds again to its mission to promote the use of steel in construction and the dissemination of scientific knowledge and innovation in the steel construction sector at national and international level.

The CMM conferences bring together designers, companies and researchers, with the participation of renowned national and international speakers. The XI Conference on Steel and Composite Construction, has two confirmed key note speakers.

Professor Ulrike KUHLMANN, keynote *"Next generation of Eurocode 3 – Evolution by improvements and harmonization"*

Professor Bert Snijder, keynote *Recent developments regarding the next version of Eurocode 3 part 1-1 on steel structures.*

Professor Ryoichi Kanno, *keynote Overview and recent advances in steel structures and materials in Japan*

With the firm aim of disseminating the latest innovations in the field of this type of construction and giving the guidelines of research in this field, encouraging the exchange of experiences, the Conference has a special focus on achievements, technology and products, hoping to contribute actively to the development of knowledge and use of steel in Portugal and to increase the competitiveness of companies in the sector.

Like the last editions, the XI Conference on Steel and Composite Construction is composed of several sections running in parallel:

– Lectures and Scientific and Technical Sessions held during the 2 days of the Congress and where the main international players in the steel construction industry are present;

– Technical exhibition, where the companies sponsoring the event demonstrate what they do best in this sector.

Themes for submitting papers:

Architecture and Steel
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Energy efficiency and sustainability of steel buildings
Industrialized solutions for building construction
Great works
Structural safety and performance of new materials and products
Execution and quality management of steel construction
Steel construction in the oil and mining industry and in the production of renewable energy

CMM once again takes an active position in the development and promotion of the national steel construction sector, expecting that this action will once again meet market needs and reach the high degree of acceptance and success of previous editions.

The deadline for submission of abstracts for this Conference is June 15 of 2017.

For more details, you can access www.cmm.pt/congresso11.

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Design of Joints in Steel and Composite Structures

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ECCS Eurocode Design Manuals

This book is the second in a series of joint SCI-ECCS publications. It will help provide UK engineers and designers with a better understanding of the design principles in the European Code of Practice for the Design of Steel Structures (EN 1993 – Eurocode 3), and the individual Part 1.8 (EN 1993-1-8) for the design of steel joints, in particular.

Reference will also be made to the associated Eurocodes for concrete (EN 1992 – Eurocode 2), and earthquake engineering (EN 1998 – Eurocode 8). This book details the basic concepts and the design rules included in EN 1993-1-8. Attention should be paid to the behaviour of the joints when designing a steel structure, in order to assure the global safety of the construction, and to control the overall cost, including fabrication, transportation and erection. Therefore, in this book, the design of the joints themselves is covered in detail, but aspects of the selection of the most appropriate configuration of joint, and integration of the joints into the analysis and the design process of the whole construction, are also fully covered. Connections using mechanical fasteners and welds are discussed, and joints that are simple, moment-resisting, and in lattice girders are considered. Various joint configurations are treated, including beam-to-column, beam-to-beam, column bases, and beam and column splice configurations, under different loading situations (axial forces, shear forces, bending moments and their combinations). The book also briefly summarises the available knowledge relating to the application of the Eurocode rules to joints under fire, fatigue, earthquake, etc., and to joints in a structure subjected to exceptional loadings, where the risk of progressive collapse has to be mitigated.

Finally, there are some worked examples, plus references to already published examples and to design tools, which will provide practical help to designers.

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66.04 Euros + VAT

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BULLONi
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Quality, rigor and respect are Factors critical for survival Of companies in a market in constant evolution...

Luis Santos
Bulloni commercial manager

Make a brief presentation of Bulloni.

Bulloni is a company dedicated to the commercialization and distribution of materials for construction and industry, namely bolting, fastening, welding and chemical products. It is headquartered in Baguim do Monte, Gondomar, with its own warehouse with 1200m2, which allows a wide stock availability.
Bulloni follows a policy of continuous improvement, focused on satisfying the needs and expectations not only of its customers, but also of its employees. We believe that a good customer service is only possible when all processes are defined and coordinated according to economic efficiency criteria, as well as a certified quality policy for its products and machines, through a safe workplace and in which all the departments work mutually on the improvement of the same and always with the aim of growing sustainably.

In what areas has Bulloni been outstanding?

Working in various market areas, we highlight as key areas of this business the construction, steel structures, wood and steelwork industry.

How is Bulloni different from its competitors?

Following the internal policy of the company, Bulloni offers its clients customized solutions, offering innovative products and certified by quality brands. We privilege the speed of delivery, counting on partners who guarantee us deliveries in 24h throughout the national territory, for the material in stock in our warehouse.
We also have a network of suppliers that allow us to have a wide range of products, thus being able to respond to the needs of our customers with special products, products according to plan and that have to be manufactured specially for a certain work.

Which projects highlight the work of Bulloni?

The service provided in the various markets in which it operates, with the certifications required by European standards, as well as the quality and reliability of our products, have gained the confidence of our clients to carry out reference works and technical installations in high demanding European markets, but also in African countries and South America.

What future challenges await Bulloni?

The constant change and updating of the market obliges the companies to be in constant development, which is why at Bulloni we believe that continuous training is the key tool to adapt not only to the challenges we know, but also to all the unexpected situations that the market can bring.

How do you see the current state of the Steel and composite construction market?

It is a demanding market with new and good prospects, especially for companies that have opted for internationalization.

Will the survival of the sector depend on cooperation between the various competitors, or on a competition capable of raising and overcoming the most competitive players?

Bulloni believes in a free market, where cooperation will always be valued, provided that the rules of this market are respected. Quality, rigor and respect are critical factors for the survival of companies in a constantly evolving market and in which we intend to grow and assimilate our position.

What are Bulloni's objectives for the years 2017 and 2018?

In the next two years Bulloni's objective is to consolidate its position in the sectors we consider to be strategic, with the Increased profitability of Bulloni and its customers being the key pillars, always offering the products with the best quality / price / guarantee ratio in the market.

How do you perceive the CMM role in the national context of the steel and composite construction sector?

We believe that CMM currently plays a very important role in this market, being not only a useful tool for disseminating the innovations related to this market, as well as one of the main training entities in this area, thus allowing all partner companies to grow and specialize in this market.

In what foreign markets does Bulloni intend to act?

At this moment the objective is to consolidate a position in the national market, continuing to support from Portugal our customers present in international markets, maintaining the quality levels proposed both in terms of materials sold and the service provided.

steelwork, construction and assembly

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Events & Exhibitions	organization	Venue	Date	information
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2017 World Congress on Advances in Structural Engineering and Mechanics (ASEM17)	International Association of Structural Engineering & Mechanics (IASEM) e Korea Advanced Institute of Science & Technology (KAIST)	Seoul, South Korea	August 28 to September 1, 2017	www.i-asem.org/new_conf/asem17.htm
ISSI-Bridges 2017 International Symposium on Structural Integrity of Old Steel Bridges	ISISE within the Conference ICSI2017	Madeira, Portugal	September 4 to 7, 2017	www.isise.net
Eurosteel 2017	Technical University of Denmark e Danish Steel Institute	Copenhagen, Denmark	September 13 to 15, 2017	www.eurosteel2017.dk
3rd International Sysmposium on connections between Steel and Concrete	Institute of Construction Materials, University of Stuttgart.	Shangai, China	September 27 to 29, 2017	www.consc2017.uni-stuttgart.de
7th International Conference on Engineering Surveying - INGEO2017	National Laboratory of Civil Engineering (LNEC)	National Laboratory of Civil Engineering (LNEC)	October 18 to 20, 2017	www.ingeo2017.lnec.pt
XI Conference of Steel and Composite Construction	CMM – Portuguese Steelwork Association	Coimbra, Portugal	November 23 to 24, 2017	www.cmm.pt/congresso11

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