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# **The Italian engineering contribution in the technical development of the new Hertziana Library by Juan Navarro Baldeweg.**

Dr Luciano Cardellicchio, University of Kent

## **Introduction**

Between 2003 and 2012, the New Bibliotheca Hertziana (Max-Planck Institute for the Art History) was built on the site of the garden of Federico Zuccari's sixteenth-century house in the historic urban fabric of Rome. The project aimed to demolish a 1960s building in the centre of Rome keeping its facades and constructing between them a more efficient, safer and more spacious building. The non-standard development of this conservation project led to the invention of several bespoke technical solutions and advanced conservation procedures. This innovative and bold construction process was developed by a pioneering engineering approach. The outcome of this experimental case study extends the building itself, having an impact on new developments in historical environments constrained by archaeological remains.

Despite the foreign origin of the architect, the structural development of this building was entirely carried on by Italian engineers who relied on the ability of crafting the construction process as a unique case study. The structural engineers involved in this project were: Alberto Parducci, Alfredo Marimpietri, Marco Mezzi e Sergio Oliviero. Despite the ambition of the project, they were able to collaborate with the architect at the 'technical design development' stage, delivering a complete new structural design without interfering with the aesthetics of the scheme, which remained untouched.

The archaeological and historical constraints, together with the complexity of demolishing and rebuilding in the centre of Rome, forced the engineers to adapt the idea of a post-tensed ribbed concrete bridge as a major building support for preserving the archaeological ruins scattered underneath the building. The structural invention allows the new building to fly over the ancient ruins without resting on the archaeological remains.

This paper aims to retrospectively discuss the contribution of the structural engineers in delivering this challenging conservation project in central Rome, analysing how the new structural systems was developed, and how it was built. The ultimate aim is to disseminate an untold story, which can unlock the potential impact of this case study for similar

constructions. This case study is generally unknown. The author of this paper delivers the major research contributions on the subject<sup>1</sup>.

### **The research environment**

This paper stems from the research project entitled ‘New building strategies for contemporary development on archaeological sites’. This project started with implementing the PhD thesis ‘The New Hertziana Library: the design proposal and its construction’ (Cardellicchio, 2007) awarded at the Faculty of Engineering of University of Rome Tor Vergata. During the early 1990s, substantial public investment was budgeted to modernise the cultural offer, the business assets and sport infrastructures in the city of Rome. This decision led to a glorious season marked with several architectural competitions aiming to provide Rome with new spaces to house innovative cultural offers, thriving new businesses and international sporting events. This strategy, politically developed and coordinated at both national and city level, gave Rome new contemporary structures such as the auditorium ‘Parco della Musica’ by Renzo Piano and the MAXXI museum by Zaha Hadid. Following this strategy, a great number of construction sites opened for erecting buildings designed by the famous foreign architects who worked in the eternal city for the very first time.

Between 1999 and 2009, during this new era of contemporary development, the PhD programme ‘Architecture and Construction’ of the School of Engineering at University Tor Vergata, started to instruct a new series of PhD research projects based on monitoring the construction process of these new city assets. The programme’s board comprised the famous architectural historian prof. Claudia Conforti,<sup>2</sup> designer and academic prof. Vittorio De Feo,<sup>3</sup> and was led by ERC award winning prof. Sergio Poretti.<sup>4</sup> The aims of these research projects were (Fig. 1):

- To investigate the unique technical development of these buildings distinguished by cutting-edge design solutions;
- To critically evaluate the technical understanding of the designers and assess qualitatively their *modus operandi* on site;
- To measure the contributions of the different professionals such as the structural and construction engineers to the final aesthetics of the building;
- To understand the degree of adaptability of the local labour (skilled and non-skilled) asked to construct non-standard design requirements;

- To record the knowledge created during the technical development and the construction process of these buildings such as new techniques, new policies, new materials and new components;
- To investigate the intellectual value of the building process of each building mapping the design modifications during the whole process stage after stage, from the first sketch to the completion of the buildings.

The degree of accomplishment of these PhD theses depended on the positive willingness of the architects, engineers and general contractors in making data available. In the case of the PhD thesis about the new Hertziana Library, the client (Max Planck Institute in Munich) and all the professionals involved fully supported the research project.

### **Methodology**

The methodology developed and refined for this research project is based on the following steps:

- a) Correlative Analysis between Technical Annotations (TA) and Aesthetic Architectural Components (AACs) in the early sketches, physical study models and competition drawings of the project for the new Hertziana Library to assess the quality and the quantity of technical information delivered by the architect and identify the starting point of the technical design process;
- b) Comparative Analysis of drawings submitted at different work stages: to identify the changes occurred to the AACs after the technical development; to define the immovable and changeable characteristics of the design throughout the process. Categorising the changes occurred to the scheme by cause;
- c) Interviews with key professional figures who contributed to the development of these buildings, such as Enrico Da Gai (project lead, Rome team), Fernando Pinos (project lead, Madrid team), structural engineers Alberto Parducci, Alfredo Marimpietri and construction manager Gennaro Esposito.
- d) Historical analysis of the construction process through archival investigations of pictures from the building site, minutes from meetings and technical reports;
- e) Empirical observation to collect data for mapping the type of labour used and the quality of the information flow between architects, engineers and builders;

The accessibility of the data was possible thanks to the generosity of all the professionals involved in the process and of the client, the Max Planck Institute in Rome, which strongly supported this research project.

### **The reason of the intervention**

The Hertziana Library is the Rome-based Italian art history research branch of the Max Planck organisation for the promotion of science in Munich. It is located in the urban peninsula of the sixteenth-century district between via Sistina and via Gregoriana, abutting Trinità dei Monti, near Piazza di Spagna and the Spanish Steps. The institution houses a sequence of three buildings side by side: Palazzo Zuccari, the *Neubau* and Palazzo Stroganoff. Palazzo Zuccari was designed by the famous painter Federico Zuccari for his workshop and residence and it was expanded and remodelled many times over the centuries. Following that, the *Neubau* (New Building) is an offspring of the old garden of Palazzo Zuccari following continuous, uncontrolled additions that took place in the last century to increase the storage space for bookshelves. The urban peninsula terminates with the nineteenth-century Palazzo Stroganoff. While the two historic buildings are used to house research workstations and offices, the *Neubau* contains the library, which contains 270,000 volumes. This substantial number of books is the result of the general growth of research activities of the Bibliotheca during the second half of the twentieth century, where a general climate of economic expansion was appreciated.

The first physical expansion of the library occurred between 1962 and 1966, when the small old buildings erected within the former garden of Palazzo Zuccari were demolished, to be replaced by a modern building providing additional storage room for books and new reading rooms. Designed by architect Silvio Galizia, the project of this modern building aimed to unify the scattered blocks built inside the original garden into a new structure called (for that reason) *Neubau*. During the construction of this building, important archaeological remains were found underneath the site. They consisted of a series of roman retaining walls dated between the first century BC and the first century AD. The archaeological investigation highlighted that these walls were occupying, in fact, the whole footprint of the former garden of the Palazzo Zuccari, extending up to the point where the Spanish Steps is today.<sup>5</sup>

In 1984, the first fire prevention regulations came into force in Italy. Following these new standards the library showed its complete inadequacy with storage areas entirely opened to

the only internal staircase of the building. In 1990, the Max Planck Institute commissioned a feasibility study to upgrade the building in compliance with the fire safety legislation.

Unfortunately, the upgrading project would have resulted in a substantial loss of storage space for books, which would have jeopardised the library's long-term feasibility. The complete inadequacy of the building complex, from the viewpoint of fire safety, was confirmed in the mid-1990s when the Fire Department threatened to close the institutions; furthermore, the impossibility of increasing its long-term book capacity eventually sounded the death knell of the building in 1994.

Hans F. Zacher (General Director of Max-Planck Estates Department) with the recommendation of Professor Christoph Luitpold Frommel (Executive Director of the Bibliotheca) decided upon a different programme of refurbishment. Zacher and Frommel called for the demolition of the *Neubau* except for the historic facades, and the commission, through a limited design competition, of a new project that would ensure compliance with modern safety standards as well as enhanced library capacity. The winner of the competition was the Spanish architect Juan Navarro Baldeweg.<sup>6</sup>

### **The difficult path towards the construction**

Immediately after the announcement of the winner, the institute faced two major problems which delayed the start of the construction for almost eight years. The first issue was legislative; the second one was archaeological. One year after the competition, nothing happened. The director of the Institute, Frommel, had to struggle tenaciously and stubbornly against the juridical lack of the City Council in terms of specific procedures that allowed the reconfiguration of the Hertziana Library. No building policy was in place to approve the demolition and reconstruction of a building (erected mainly during the 1960s) in the middle of the historic centre of the city, in violation of the specifications of the General Zoning Plan which provides only 'conservation, restoration or refurbishment' for new development in that area. The Building Commission would have never approved a project based on the total demolition of a building just a few metres from Piazza di Spagna and its reconstruction, in line with a project that did not yet have the detailed drawings required to comply with current building regulations. The legislative issue was solved with the assistance of the Roman architect Enrico Da Gai, appointed by the Max-Planck Institute to untie the bureaucratic knots for approval of the project. The procedure agreed with the Council was a 'Urban Restoration Plan' that, signed jointly by Da Gai for the Bibliotheca Hertziana and architect Paolo Riccetti

for the City of Rome, allowed the demolitions of the buildings erected in the former garden of Palazzo Zuccari.

Following approval of the planning matters, the institute had to deal with the second issues related to the technical development of the project: the presence of substantial archaeological remains underneath the whole footprint of the *Neubau*.

To allow the construction of the new library and preserve the archeological ruins in compliance with the Italian law of archeological conservation a groundbreaking structural project was conceived. The team of engineers in charge of the structural development included Prof Alberto Parducci, at that time full Professor of Structural Engineering at the University of Perugia, Marco Mezzi, Associate Professor of Structural Engineering at the University of Perugia, Sergio Oliviero, full Professor of Geotechnical Engineering at the University of La Sapienza and Alfredo Marimpietri, structural engineer with an extensive experience on-site. Da Gai who, after achieving the right of demolition for the old building, was appointed project leader and technical designer for the whole development process of the library, managed the coordination between the team of engineers and the main architectural office in Madrid (Juan Navarro Baldeweg Asociados).<sup>7</sup>

This coordination between the technical team and the main designer led to a solution where the project submitted at the competition stage remained unaltered. The new structural project only modified the three underground floors, which were redesigned to permit the installation of a large structural device conceived by Da Gai, designed, and developed by Parducci and Marimpietri. The project was to support the new building with a bridge system able to span for 26 metres over the archeological ruins, resting only on two narrow strips of land (1.5 metres wide) outside the historical facades (Fig. 2).

The major component of this bridge system is a three metres deep ribbed platform in reinforced concrete, shaped with pre-stressed concrete ribs aligned along the primary way of spanning, between via Sistina and via Gregoriana. Along the historic facades, two long series of piles were then designed to support the platform and transfer the substantial gravitational and lateral loads to the ground. On top of this platform a steel frame structure was considered the most feasible to overcome the inaccessibility of the site area restricted by its surrounding historic urban fabric.

In order to meet the design requirement, the platform was carefully shaped to support the building without modifying the position of the load-bearing columns decided at the

competition stage.<sup>8</sup> The result of this approach led to a structural component entirely bespoke and not geometrically rationalized where the ribs were aligned in different directions to meet the scattered columns of the frame above. The platform, which consists in two floor slabs and the concrete walls between them, was conceived with hybrid building techniques to turn this structural object into a direct instrument to investigate the archeological ruins within the building footprint. The slabs were designed with special slots to allow the removal of the soil used initially to support the formwork of the platform. The slots were designed to permit, at the same time, a meticulous stratigraphic archaeological investigation underneath the platform and the assembly of the metal structure above it (Fig. 3). Following the archeological campaign the slots were closed with the use of metal deck finished with a layer of reinforced concrete. This system allowed the slow archeological investigations without interfering with the assembly of the metal frame. This new building strategy will have an impact on future development in historic areas.<sup>9</sup>

### **The Construction: a craft approach**

Since the beginning of the demolition phase of the old building, it had been evident to the building contractor that the technical requirements of the project would justify the deployment of unconventional construction methods led by a craft approach. The low level of mechanization, the small degree of standardization, and prefabrication of the building components and the use of intense labour for the majority of the work, are the key elements of this construction process.

The main problem faced by the builder was the inaccessibility of the site area, which was restricted by two adjacent historic buildings (Palazzo Zuccari and Palazzo Stroganoff) and by the historical facades. All material – such as debris from demolition, or the casting of concrete for the foundation system, or the metal components for the new structural skeleton, or the glass panel of the glass facade – was put in place with a precise and strict sequence of crane moves. No gap wide enough on the facade was available to provide a quick connection between the interior of the building to the small loading area located outside along via Gregoriana (Fig. 4). Overall, in order to better understand the logistics involved in the construction, it is important to note that during the demolition and reconstruction, different kinds of structures were in place within the original void of the Zuccari garden at the same time. For several years the structure of the old building, the provisional elements that braced the facades during the demolition phases, and portions of the new structure, were all located



within the narrow site. One of the aims, for instance, was to use the skeleton of the *Neubau* to brace a portion of the historical facade, and in so doing reduce the impact of provisional elements (Fig. 5). The phases of execution did not follow each other in a systematic sequence such a ‘demolition before construction’, but overlapped chronologically. This means that during the period of construction, some parts of the *Neubau* contributed substantially to the construction of the new one.

The whole construction process featured many innovations led by solutions to unexpected issues occurred on site. The first detail successfully accomplished on site was the injection-valve for the steel pipe used to reinforce each micro-pile. Due to a very incoherent stratigraphy on via Gregoriana scattered pockets of gravel interrupt the layers of lime. The gravel compromised the first attempts of cement injections by blocking the holes.

This caused many failing piles, which were used as tests. With an improved return-limiting valve and a new drilling procedure developed by washing the surface of each hole, the construction of the piles along via Gregoriana was completed in six months (Fig. 6).

The most complex phase was the construction of the massive base/bridge in pre-stressed concrete. The construction of this large ribbed slab was managed in two different times: at first workers casted the two supporting wings outside of the building, along both via Gregoriana and via Sistina, while the demolition of the old library was still running. Secondly, the concrete ribs and floors of the platform were built. (Figs 7-8).

Only a craft approach from the builder could guarantee high quality standards when assembling the massive wooden formwork. As noted above, no portions of the structure were precast. The carpenters first assembled the rails, which would hold pre-stressed ribs three metres high; within a month, the entire footprint of the future buildings had been covered by this unique and non-standard formwork. Iron bars were then put in place to erect the thick cages that would reinforce the ribs before casting the material. In order to construct the ribbed slab, the ‘craftsmen’ of the construction firm were required to extricate themselves from tight spaces, bend bars into dense tangles, assemble timber work in various alignments, and ensure the concrete filled every single space of the formwork, all the while respecting the highest standards of safety. The casting of all the concrete was conducted by transporting small quantities of concrete from the mixer parked on Via Gregoriana, within the construction site, and only through a collecting basket hanging on the crane. To make this phase even slower all the casting must have scheduled during the early hours of the morning before the traffic of the historic centre became a further obstacle for the mixer in order to reach the loading area.

## Conclusion

A decade passed from the beginning of the construction until the opening of the library. The archaeological problems were the main cause of this substantial delay. A continuous succession of difficulties and unexpected events marked the construction of the new Hertziana Library. The environmental constraints of the area; the severe lack of space for vehicles and construction machinery; a construction sequence marked by the progressive removal of old parts to supply room for the new structure; and the complex logistics of storing materials were the most challenging issues faced during these ten years. The works was not conducted on a time schedule composed of a regular succession of phases: in fact, the construction management of the site was based on the simultaneous interaction of a number of processes.

Contact: [L.Cardelicchio@kent.ac.uk](mailto:L.Cardelicchio@kent.ac.uk)

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<sup>5</sup> G. Kaster, *Die Gärten des Lucullus. Entwicklung und Bedeutung der Bebauung des Pincio-Hügels in Rom*, Master dissertation discussed at Technische Universität München. Supervisors: Prof. G. Gruben, H. Weirmann.

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<sup>7</sup> M.M. Segarra Lagunes (Ed.) *Proceedings of the Forth National Conference ArcCo*. Rome: Gangemi 2001. E. Da Gai, *Il progetto di restauro e di recupero della Bibliotheca Hertziana a Roma*, Vol. I, , pp.87-100.

<sup>8</sup> The design report submitted for the competition is fully published in: J.N. Baldeweg, *Ristrutturazione della Bibliotheca Hertziana*, 'Zodiac', n.17, Milan: Editrice Abitare Segesta, 1997.

<sup>9</sup> L. Cardelicchio, *Method for a contemporary archeology*, 'D'Architettura', 33, Milan: Motta Editore, 2008, pp. 66-79.