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Envisioning the Futures - Designing and Building for People and the Environment

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Preface

The annual series of technical conferences on Architectural Engineering (AE) brings together academics and experts to discuss recent advancements in building sector research, assess the performance and impact of existing and new buildings, evaluate technological solutions at different project scales, analyse complex systems to identify intervention scenarios, and provide processes, tools and models to improve the safety, resilience, and sustainability of the built environment.

The 2025 edition of Colloqui.AT.e took place at the University of Trento in Italy. The event aimed to give all participants the opportunity to share their technical and scientific experiences, particularly in light of its thematic focus: Envisioning the futures: Designing and Building for People and the Environment.

The recent history of the construction sector can be divided into three main phases of development. The first phase occurred at the beginning of the so-called green revolution and was characterised by a prevailing focus on the environment at different scales, as well as the definition of sustainability issues in all their nuances, such as adaptation, mitigation, resource protection, reduction, recycling, and circularity. The second phase aimed to renew interest in people and their needs, including primary needs such as safety and security, user-centred environments, comfort, well-being, and health. The third phase, which is still ongoing, has focused more on digitalisation tools in various fields, ranging from data acquisition (sensors, IoT, 3D scanning) and process automation (robotics, 3D printing and drones) to digital analysis and information (multi-dimensional BIM, virtual and augmented reality, digital twins, and AI-based technologies).

This process, which is now almost 40 years old, has been supported and guided by European programmes (to which national and local programmes have referred over time, most recently the PNRR), which have attempted to coordinate and revitalise the sector jointly. Examples of these programmes include the Green Deal, Horizon Europe, Digital Europe, the New European Bauhaus, the Recovery and Resilience Facility and InvestEU.

However, the construction sector, which is an important part of the economy of both our country and the EU, is in a state of continuous crisis, largely due to economic factors hindering its development, such as temporary building bonuses and tax incentives, limited public investment, the low liquidity of enterprises, and the progressive impoverishment of households. This is compounded by the difficulty of constantly updating the technological (including digital) and managerial skills of those involved in the construction process, whether public or private. Finally, there is an apparent dichotomy between the needs of the industry and those of users, which are difficult to formalise in rigid and often poor-quality logic, even if it is economically advantageous.

Therefore, there is a need to systematise the essential aspects of the construction sector according to three criteria: integration (of people, buildings and communities); circularity (efficient and economic use of resources); and simplicity (in planning, design and construction). This will enable us to envisage not just one possible future, but multiple "futures" that align with the aspirations of the younger generation and offer principles, processes, solutions, technologies, and products linked to digital transformation, both in new constructions and in the existing heritage. These must be addressed in a synergistic and integrated manner to meet the evolving needs of people and enhance the quality of indoor and outdoor environments.

As for the first Colloqui.AT.e conference launched in Vico Equense, Naples, Italy 2014, also the 2025's one has been centered on three different topics related to the main fields of research in AE: "Construction and Conservation History"; "Construction and building performance"; "Building Design and Technologies". These topics have allowed researchers and engineers to discuss the latest developments in the AE area at an international level, particularly by providing tools, methods, and models (including digital ones) for the knowledge and design of buildings from critical, systemic, functional, typological, technical, and constructive points of view. This has also involved exploiting technology transfer from other fields of research belonging to different scientific sectors close to AE.

The three topics have been defined as follows:

A_Construction and Conservation History
A1. Materials and construction techniques in historical architecture
A2. Recovery, valorization, and reuse of existing building heritage
A3. Examples of interventions on monumental architecture
A4. Examples of industrial archaeology between knowledge and reuse
A5. Vernacular architecture: lessons learned and future projects
A6. Projects and policies for the regeneration of historic centers and suburbs
A7. Digital twins and immersive visualization for the valorization, management, and fruition of historical building heritage

B_Building Construction and Performance
B1. Traditional and innovative technologies and materials for buildings
B2. Modeling, simulation, and diagnostics under uncertainty for performance control
B3.Building pathologies and intervention strategies
B4. Building-human-environment relationships: extended accessibility
B5. Building management and maintenance for safety and quality of living environments
B6. Mitigation and management of vulnerabilities and risks for the preservation of the built environment
B7. Regulatory updates, quality control of the project, and construction process

C_Building Design and Technologies
C1. Form, technique, and technology
C2. Circular design, embodied carbon, and extended buildings life cycle
C3. Digital transition and design of 4.0 buildings
C4. Technological innovation: processes, patents, and products for the construction of the future
C5. Integral and participatory design for the quality of the built environment
C6. Adaptive and responsive buildings
C7. DfMA–Design for manufacturing and Assembly and DfD–Design for disassembly

During the conference, 12 selected papers (out of the 140 scientific contributions received) and three keynote lectures were presented. The invited keynote speakers were: Eugenia Gasparri, Senior Lecturer in Architectural Technologies and Associate Dean of Research Education at the University of Sydney, Australia, whose speech was titled "Rethinking Building Skins: What's Next on the Façade Horizon"; Charles Spence, Professor of Experimental Psychology and Head of the Crossmodal Research Laboratory at the University of Oxford, UK, whose speech was titled "Sensehacking Wellness"; and Werner Tscholl, architect in Laces, Val Venosta, Province of Bolzano, Italy, whose speech was titled "Concept Follows Context".

The three volumes collect all the papers that were submitted and underwent double-blind peer review, and they demonstrate that an AE multidisciplinary approach can effectively contribute to analysing and solving problems affecting buildings, cities, and the built environment. This can be achieved by suggesting innovative technical solutions, materials, components, and strategies that can guarantee the preservation of building heritage, the well-being of users and appropriate action to counteract climate change.

The Colloqui.AT.e2025 conference has been jointly organized by Ar.Tec. Scientific Society and the Department of Civil Environmental and Mechanical Engineering of the University of Trento, with the Patronage of: Municipality of Trento, Order of Engineers of the Province of Trento, Order of Architects of the Province of Trento, Habitech–Technological district of Trentino, Ance Trento-Trento Building Association, Universitat Politecnica de Valencia. The conference was sponsored by: INNOVA S.r.l. (www.innovaenergie.com), Riwega S.r.l. (www.riwega.com), Rockwool Italia S.p.a. (www.rockwool.com), Rothoblaas S.r.l. (www.rothoblaas.it), Miniera San Romedio S.r.l. (www.tassullo.it), XLAM Dolomiti S.p.A., together with Banca per il Trentino-Alto Adige (www.bancapts.it), Sovecar S.r.l. (www.sovecar.com), LSI-LASTEM S.r.l. (www.lsi-lastem.com), Manni Group S.p.A. (mannigroup.com), Ri-Legno S.r.l. (ri-legno.it), and supported by Melinda (melinda.it).

On behalf of the Colloqui.AT.e 2025 organising committee, we would like to express our gratitude to all the keynote speakers and authors, as well as the members of the international scientific and advisory committees. We would also like to thank all the participants who took part in this important international scientific event.

Special thanks goes to the publisher, Springer Nature Switzerland AG, and in particular to Pierpaolo Riva, for his support in publishing the Colloqui.AT.e 2025 proceedings. This contribution has significantly enhanced the dissemination and impact of our research activities in the field of architectural engineering. As members of Ar.Tec. Scientific Society, we are committed to continuing the tradition of the Colloqui.AT.e International Conferences in spreading the knowledge, excellence, and innovation of our research in the building sector.

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Contents

Construction Ingenuity and Aeronautical Experimentation: The D.S.S.E. Construction Site in Guidonia as a Laboratory of Innovation

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Abstract. The site has always been a place where technological innovation meets new materials and construction techniques, and can be a real research laboratory, where experience and technique are combined to meet the needs of the reference context. In this perspective, the present contribution aims to decode the innovative approach adopted in the implementation of the Higher Direction Studies and Experiences of Guidonia and to understand the construction processes through the distinct phases of the construction site. The investigation, conducted by reading photographic documentation, has allowed to reconstruct the organization of the site and the strategies adopted to build buildings with advanced technological characteristics. Particular attention is paid to the construction of the site and its functions that have allowed the realization of complex futuristic, such as wind tunnels, hydrodynamic tanks and laboratories for aeronautical tests. This perspective highlights how the management of the construction site and the building process fits into an integrated knowledge system, where different skills are interwoven to give life to new architectural and engineering solutions. In a period marked by economic and political constraints, the site is not limited to being a simple place of "do" but becomes the place for new opportunities for research on materials and modern construction techniques, creating a significant model of synthesis between architecture and industry.

Keywords: Construction Innovation · Rationalist Architecture · Aeronautics · Experimental Techniques · Guidonia D.S.S.E

1 Introduction

The contemporary debate is increasingly tending to highlight historic construction sites as places of experimentation where the skills of architects, engineers and skilled workers were interwoven in a continuous dialogue. Architecture is the voice of construction processes, economic, political, social and cultural dynamics that shape the form and function of buildings. Investigating the "history of the site" means fully understanding the technologies, materials and work systems adopted, comparing them with current ones and identifying their continuity and innovations. In the specific case of early 20th century

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architecture, the recovery and study of archival documents and historical photographs of construction sites take on a special value, because they allow to reconstruct a crucial phase of the transition towards the modernity of Italian construction [1]. At the same time, the bases are identified to outline a real technical manual of Modern architecture, useful for understanding the design and construction methodologies adopted on a large scale. Often these are "hybrid" solutions, dictated by established knowledge and combined with modern innovative ideas (mediated by local needs) especially in the transition from the prevailing use of load-bearing masonry to reinforced concrete structures. Understanding these dynamics is essential to appreciate how the design idea, at the base of modern buildings, translates into execution practices and how different actors interact to shape the work under construction [14].

In the case of the Guidonia construction site, this step is even more marked by the desire to confer importance on the evolution of the Italian Air Force, through the role of the experimental laboratory in the use of new construction techniques and futuristic buildings.

1.1 Research Aims and Methodology

The contribution is part of a broader research devoted to the study of aeronautical constructions in a period of intense experimentation, analyzing how the construction site has become the starting point for critical thinking and scientific reasoning. Through the investigation of the construction phases, the technologies used, and the design choices made, this approach allows us to understand how the building process has been shaped by the introduction of new methods and technologies.

To support this investigation, we draw on a considerable amount of archival and photographic documentation from the State Central Archive and the Historical Archive of the Air Force, which allowed a more detailed understanding of the construction methods, organizational challenges and stylistic-structural solutions adopted. In the case of the Direzione Superiore Studi ed Esperienze (D.S.S.E.), the role of the construction site tends to emphasize the innovative idea of a complex created for the experimentation on flying boats, where the ingenuity had to be confronted with new ideas of organization, construction and implementation. The method of analysis adopted combines the examination of photographs, design tables and archival documents, in order to highlight the strategies, machinery used and technical experiments that have characterized it. In this sense, the photos will allow us to identify a new point of view, which is how the aeronautical center embodied, already during its construction, an "experimental" nature and oriented towards innovation.

In the analysis of the architecture of the complex, particular attention was paid to the characteristics of each building, highlighting its most significant and innovative aspects. The images of the time will allow to return and highlight the design and technological aspects that determined their realization, thus offering an important contribution to the knowledge and exploitation of this heritage.

2 The Higher Directorate of Studies and Experiences of Guidonia

2.1 Historical Events

The birth of the Direzione Superiore Studi ed Esperienze (D.S.S.E.) in Guidonia took place in a period of profound transformation, marked by the establishment of new military infrastructures and the drive towards technical and scientific modernisation in support of the Air Force.

The desire to create a specialised aviation centre was based on the strategic importance that the military authority attributed to the development of flight, which was essential to guarantee Italy an internationally competitive air force. The wide availability of land and the presence of an already active airport were the prerequisites for identifying Guidonia as the ideal location in which to concentrate laboratories, flight departments and specialised workshops [2]. This decision involved the elaboration of a coherent plan followed by the realisation of an urban and infrastructural layout, to ensure a rational organisation of research, production, and military personnel management functions (Fig. 1).

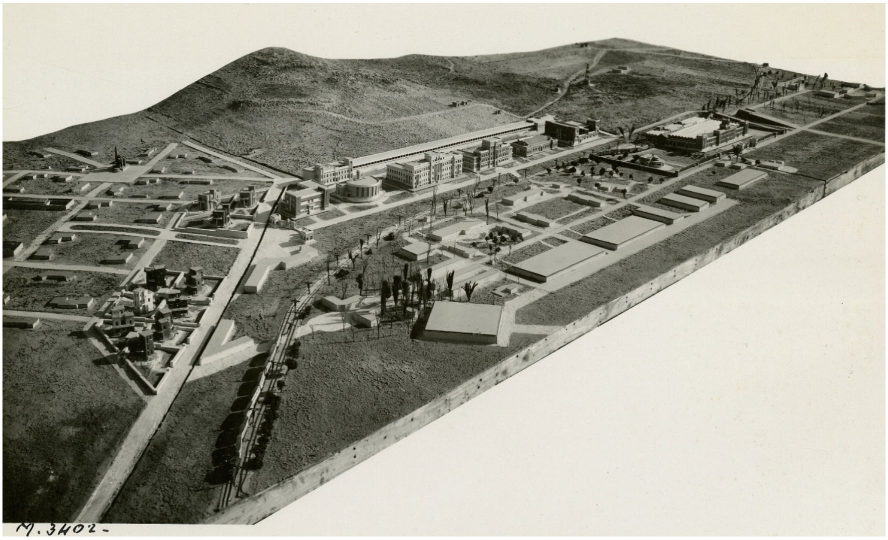

Fig. 1. View of the model made for the construction of the. D.S.S.E. (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

As happens with many large public works, the definition of funds and the methods of implementation was based on specific regulations and laws aimed at supporting military and scientific buildings of national interest. The decision to support these expenditures with dedicated resources testifies to the primary role that the Air Force intended to play, placing the D.S.E. as the 'experimental hub' of the national aeronautical sector [3]. The vision was that of a facility that also represented, in a broader sense, the country's capacity for innovation: a place conceived in a functional manner, but endowed with an authoritative architectural image, consistent with the dictates of the historical period and the need to communicate prestige. In this perspective, the D.S.S.E. was recognised as a centre capable of bringing together, in a single pole, the skills of experienced scientists, engineers and military technicians. The chosen location, which integrated existing airport infrastructures and major new works (such as hydrodynamic basins and aerodynamic tunnels), was perfectly justified: the site, which was sufficiently large and flat, lent itself well to research and flight purposes [11]. The general design envisaged the division of the area into highly specialised zones, arranged in such a way as to facilitate a rapid transition from the experimental to the operational phases of aircraft testing. The result was an 'aeronautical campus' with a modern layout, inspired by principles of spatial efficiency, updated in terms of construction, and upgraded in terms of infrastructure to meet the challenges of a constantly changing aeronautical sector (Fig. 2).

Fig. 2. External and internal views of the D.S.S.E. aeronautical construction plant; (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

2.2 The Project and the Architectural Layout

The Guidonia Direzione Superiore Studi ed Esperienze, while not being attributable to a single designer, reveals an architectural layout designed to combine monumentality, rationality, and innovation. The idea was to create a complex capable of accommodating various functions in an orderly manner: research laboratories, workshop spaces for the construction and maintenance of mechanical parts, hangars for experimental aircraft, management offices and support facilities (Fig. 3).

Fig. 3. Photo of the main avenue of the D.S.S.E. Construction Site. (fonte: Archivio Centrale del lo Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

The focus was therefore on an essential architectural language, with sober volumes and restrained symmetries, recalling the authority of the military institution but at the same time easily adaptable to the technical specificities required by each section [4]. The plan, for reasons related to the orography of the terrain and the presence of railway infrastructure, was articulated around a main axis of development, along which the major buildings were arranged [2]. The buildings intended for management and administrative services had a slightly more monumental character, with compact fronts and a regular order of openings, while the spaces dedicated to the workshops and flight experiments were characterised by the need for large spans and light roofing solutions, capable of guaranteeing easy access to machinery or aircraft (Fig. 4).

Fig. 4. On the left, internal photo of the hydrodynamic tank under construction; in the center, photos of the Wind Tunnels laboratory; on the right, Aeronautical Construction Plant with detail of the steel canopy. (fonte: Archivio Centrale dello Stato, fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

The geological characteristics of the site posed significant questions when it came to building large test tanks, aerodynamic tunnels, and hangars of vast proportions. To meet these requirements, a variety of foundation solutions were adopted, including reinforced concrete slabs and 'mixed' type elevation structures, characterised by metal profiles to support the masonry parts capable of absorbing dynamic stress. The search for innovative materials was reflected partly in the use of reinforced concrete in the load-bearing frames and partly in the use of steel or iron profiles for the construction of substructures to support buildings in which it was necessary to support high loads or provide for the installation of heavy machines.

Stylistically, the exterior cladding was sober, characterised by brick elements or simple plasterwork, while the decorative apparatus was limited to details that emphasised the official nature of the institution such as coats of arms, commemorative plaques, and simple projecting cornices. On the inside, the volumes destined for executive activities were equipped with more elaborate finishes, unlike the experimental pavilions, which had flooring suitable for handling materials and spaces easily accessible to machinery. Overall, the project pursued a balance between monumentality and practicality, adopting an architectural language that could stand up to the rhetoric of the time, but was also capable of supporting the intense scientific and technological life that the D.S.S.E. would host within it.

Compared to works of a celebratory nature, in the case of Guidonia there is an underlying pragmatism, dictated by the operational needs of a complex that not only had to appear authoritative, but above all function as a great laboratory of mechanical flight and a pole of industrial production at the service of aeronautics (Fig. 5).

Fig. 5. Photo of the façade of the Aeronautical Construction Plant under construction. (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

3 The Construction Site of the Main Buildings of the D.S.S.E.

As already mentioned, the Guidonia experimental centre stands out for a set of buildings conceived with highly specific functional purposes, realised through technical-constructive solutions that were particularly innovative for the time. These buildings, organised along an important railway link, present an architectural language that in some cases even turns out to be futuristic, reflecting the different operational requirements to which each structure was called upon to respond. The construction of the complex was possible thanks to the Società Italiana Costruzioni e Lavori Pubblici, as evidenced by some of the signs visible in the historical images of the construction site (Fig. 6).

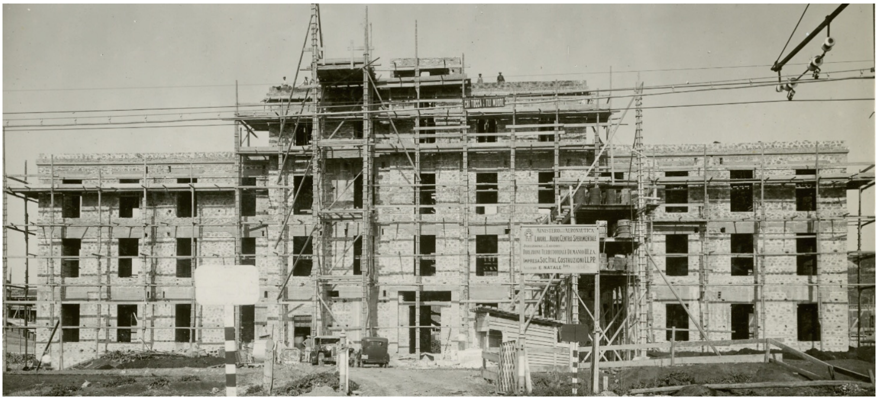

Fig. 6. Exterior photo of the construction of a building of the D.S.S.E (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

After the purchase of the lots, the company was responsible for the management and construction of the entire project, coordinating the organisation of the workers and the organization of supplies.

The images clearly show the main buildings constructed, including the hydrodynamic tank, the pavilions dedicated to aerodynamic studies (such as the Wind Tunnels, the Double Return Tunnel and the Stratospheric Tunnel), the Power Station and the Aeronautical Construction Plant, the latter conceived as a place for the operational translation of scientific experimentation. The period photographs also offer an insight into the construction techniques employed, particularly on the external service scaffolding, revealing design solutions of remarkable ingenuity and functionality.

Even though they might appear simple in their configuration, these scaffolds were constructed with great care: the horizontal stringers were inserted directly into the infill masonry to create anchorage points, while the connections to the vertical uprights, known as ‘ritti’, were tied with mechanical systems such as ropes or nails [13].

The configuration of the ‘ritti” varied according to structural needs, with solutions designed to suit the height of the buildings and the loads to be supported. In some cases, twin combinations were observed, in which the uprights were rigidly connected by means of solid wooden boards, forming a stable, almost monolithic structure. For taller buildings or more complex construction situations, systems consisting of several posts, joined together by means of wooden jaws and ropes, were adopted, providing operational security on the construction site (Fig. 7).

Fig. 7. Detail of the service scaffolding and the connections between them (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo-direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

An emblematic example of the technical complexity of the site is the hydrodynamic tank, located further north in the complex. Approximately 436 m long, it was designed to conduct tests on seaplane models and structures in marine trim. Its construction required a particularly rigid structure, capable of holding large volumes of water and minimising vibrations. The heads of the building, destined for study offices and technical services, presented a more elaborate architectural language; the long side walls, on the other hand, punctuated by horizontal openings, were inspired by rationalist principles and an industrial-type functionality [5]. The images of the construction of the complex render an extremely organised building site and reveal some of the solutions adopted to manage a work of such dimensions. On the outside, wooden scaffolding ran along the elevations, with vertical uprights and horizontal planks defining various levels of intervention, allowing workers to gradually work on the completion of the upper floors, to remove waste materials in parallel and to efficiently organise the flow of supplies.

To facilitate the movement of blocks and sections, rails (of the 'Decauville' type) were also used through which trolleys or wagons loaded with materials could be moved [13] (Fig. 8).

Inside the tank, the photographs show the perimeter stonework and brick planking, on which horizontal reinforced concrete elements were placed. The extensive network of planking and scaffolding served not only as support for the formwork and concrete casting phases, but also as a temporary storage platform for reinforcement and formwork. At the bottom of the tank, wooden formwork and planks, indicative of a dismantling or cleaning phase, can be recognised, and the continuity of the masonry across several rows can be noticed (Fig. 9).

The alternation between masonry and reinforced concrete structures is clearly visible: on the one hand, the thickness of the stone blocks; on the other, the corbels and beams that support the roof of the pool. In these interior views, you can see how these beams penetrate the roof to provide large open spans over the main canal.

Fig. 8. On the left, external photo of the hydrodynamic tank under construction, with scaffolding. On the right, external viewof the construction site of the Guidonia Higher Studies Directorate of Experiences in the construction phases: detail of the track for the transport of construction site equipment and goods (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

Fig. 9. Interior views of the hydrodynamic tank under construction (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie.).

Other shots show the metal reinforcements along the bottom and walls of the pool: a dense grid of horizontal and vertical steel bars, ready to form a solid ‘cage’ at the moment of pouring, to resist hydrostatic shocks and any dynamic loads [6, 7]. In the next stages, these kerbstones would become the laying surface for the installation of the rails, supported by a series of IPE girders running along the entire building, as shown in the photographs. These tracks would have housed the dynamometric bridge crane, an essential tool for testing experimental seaplane models (Fig. 10).

Opposite the Hydrodynamic Gallery is the Aerodynamic Laboratory, which had a dual purpose: on the one hand, to conduct systematic research with relevant civil applications and, on the other, to meet the specific needs of industry and the Regia

Aeronautica for advanced experiments. This structure consisted of three main buildings: the wind tunnels, the double return tunnel, and the ultrasonic stratospheric tunnel [10]. The wind tunnels, designed to generate high speed air currents, were one of the most complex and technologically advanced aspects of the complex. They required reinforced concrete frames of considerable strength, capable of supporting particularly powerful motors and fans, as well as ensuring environmental stability and vibration containment. As a result of these requirements, the external masonry was often reduced to simple infill, while the load-bearing structure was based on large-section columns and beams. During construction, in addition to traditional wooden scaffolding for moving heavy materials, extensive use was made of cranes, winches and pulleys, which were essential for speeding up the pace of work and maintaining a regular workflow (Fig. 11).

Fig. 10. Interior views of the hydrodynamic tank under construction (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie.).

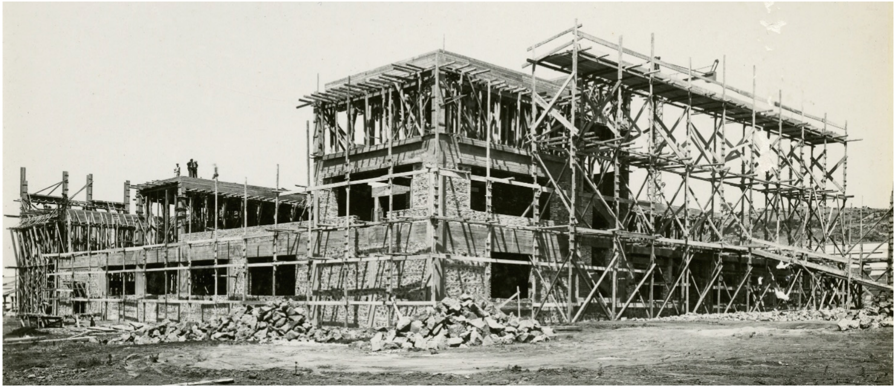

Fig. 11. Exterior view of the plant Wind tunnels under construction (Vista Sud-Est); (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie.).

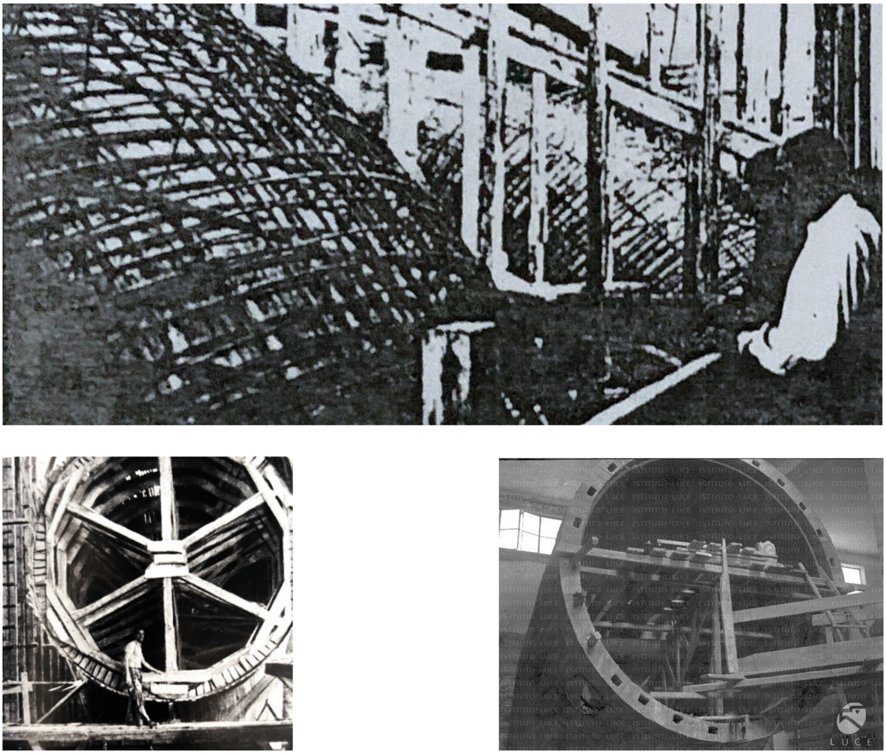

Fig. 12. Photos of the construction phases of the Wind Tunnels; above, photo of the armor of the backs of the Wind Tunnels before the casting; on the bottom right and left, photos of the wooden ribs used to form the circular section for the overhang (fonte: Archivio Storico dell'Aeronautica Militare (Roma), Archivio dell'Istituto LUCE).

As can be seen from the photographs, the tubular section of the tunnel was defined by a system of wooden ribs with a circular profile, repeated along its entire length; the work was carried out from bottom to top, starting with the reinforced concrete slab, then the basement section, until the upper overhangs were completed [12]. Some images offer a perspective from below, showing how the scaffolding adhered to the gallery itself, testifying to a methodical and serial construction process (Fig. 12).

The aerodynamic sector was completed by the Double Return Tunnel and the Ultrasonic Stratospheric Tunnel. The former, developed according to General Crocco's design, allowed higher speeds to be achieved than in traditional aerodynamic tunnels. Its external form was not a mere shell but clearly expressed the function for which the building was designed. The dynamism of the lines shows how these structures were part of a new architectural language, far removed from the standard practice of the time. The Stratospheric Ultrasonic Gallery, on the other hand, was located inside another building, placed in front of the previous one and developed on two levels.

The ground floor was occupied by the experience room, workshop, and adjoining offices. The basement housed the gallery return. The structural peculiarity of the building was the presence of two separate foundations on which the building rested, consisting of two independent parts: one to house the rotating machinery and the gallery, and the other to house the switchboard and the perimeter walls.

These design solutions were not entirely accidental but responded to the need to isolate the vibrations generated by the machinery, preventing them from being transmitted into the building and compromising its stability. It was in these rooms that the groundbreaking tests were carried out, which resulted in the sound barrier being broken for the first time [5, 6]. For these two buildings, the few photographs available show the state of construction only after completion, allowing us to appreciate only the architectural features (Fig. 13).

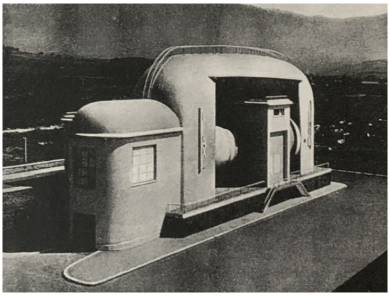

Fig. 13. Photo of the end of the construction site: on the left, external photo of the Double Return Gallery; on the right, external photo of the stratospheric ultrasonic gallery. (fonte: Atti di Guidonia. A cura della Direzione Studi ed Esperienze del Ministero dell'Aeronautica. Volume I, 1941).

The power station, located to the east of the complex, was the energy hub and the functional completion of the entire aeronautical centre. It provided the necessary laboratories, workshops and experimental tunnels and was therefore essential for the full operation of all research activities [8]. From a structural point of view, the power station had to meet specific stability and strength requirements due to the installation of heavy, high-power machinery such as turbines, generators and transformers. For this reason, particularly strong foundations were chosen, capable of absorbing considerable vibrations and dynamic loads, combining the reinforced concrete structure with the use of horizontally vaulted masonry base enclosures to ensure greater stability of the building.

The architectural language, although based on criteria of simplicity and rationality, showed its monumentality by highlighting the strategic role of the power station within the entire complex. The building had a longitudinal layout on three levels [12]. Unlike other D.S.S.E. structures, which were characterised by the extensive use of metal profiles, the power station mainly used a reinforced concrete frame with masonry cladding, a solution also dictated by the self-sufficiency constraints limiting the use of iron; in this way, in addition to reducing the need for large quantities of steel, it was possible to guarantee the appropriate rigidity and resistance to vibrations caused by the operation of the internal machinery. Other special features include the use of a "C" type Stimip plate, a special configuration that allowed the heat generated by the internal turbines to be reduced (Fig. 14).

The Aeronautical Construction Building, located to the south of the railway junction, was a crucial transitional element between the 'theoretical' study phase and the 'empirical' implementation of aeronautical discoveries. It was in this building that full-scale models were built for testing and experimentation, providing essential support to the Air Force (Fig. 15). As can be seen from the accompanying photographs, unlike the other buildings in the complex, the process of construction standardisation played a fundamental role here: the need to construct the building in a relatively short time and with reduced energy consumption led to the definition of a rectangular floor plan, characterised by a strip masonry system and a reinforced concrete frame that served as a framework for the internal partitions. Of particular interest is the "shed" roof, a solution which, in the age of self-sufficiency, allowed the use of materials to be optimised and natural light to be used to illuminate the building. The north-facing glass pitch provided diffused lighting for many hours of the day, reducing energy consumption while providing a well-lit working environment [9]. The metal grid structures supporting the roof were mechanically anchored to the main concrete frame, allowing the prefabricated elements to be quickly assembled on site (Fig. 16).

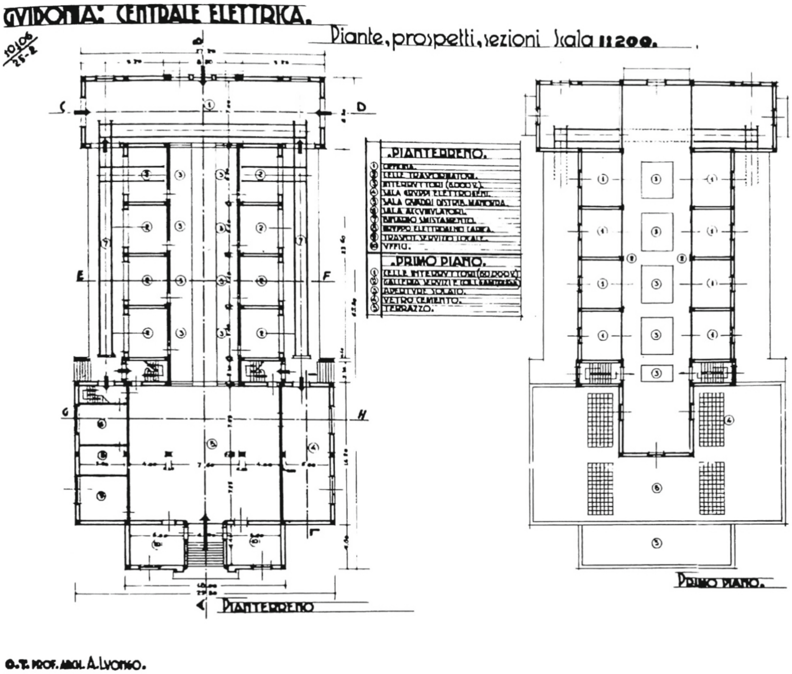

Fig. 14. Plan of the Power Plant - Higher Directorate of Studies and Experiences. (fonte: Mario Ranisi. L'Architettura della Regia Aeronautica. Stabilimento Grafico Militare (Gaeta). 1991).

Fig. 15. External overview of the construction phase of the Aeronautical Construction Plant (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

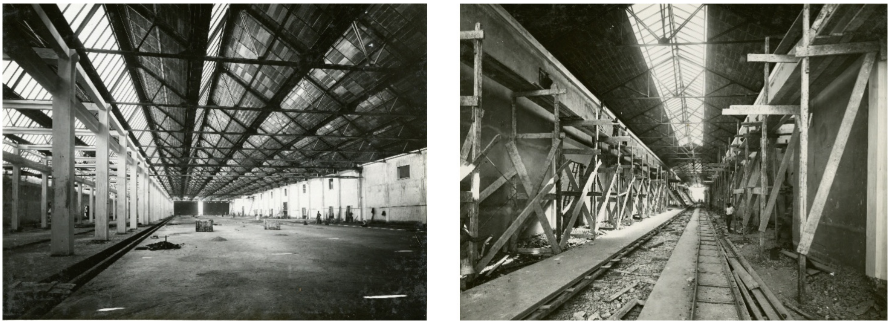

Fig. 16. Interior photos of the construction site of the Aeronautical Construction Plant (fonte: Archivio Centrale dello Stato- Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

The photographs show how the site was organised to ensure efficiency and speed: in some you can see tracks inside the building, useful for transporting materials, and you can see the presence of a large crane, thanks to which it was possible to lift and position the prefabricated components of the roof at height. The arrangement of scaffolding and linear scaffolding, combined with the use of mechanical lifting equipment, ensured a regular and well-coordinated construction process, an essential condition for a structure in which "construction knowledge" and "testing functionality" had to complement each other to the full. This factory was designed as a building where aeronautical experimentation could move quickly from the design phase to the realisation of real models, thus enabling the validity of the research carried out in the laboratories to be verified in a short space of time. The combination of standardised construction systems, a skilfully dimensioned concrete frame and the "shed" roof in iron and frosted glass testifies to the desire to create an efficient, well-lit, and functional workplace to meet the needs of a constantly evolving aeronautical production [8, 9].

Taken as a whole, the buildings that make up the D.S.S.E. show a remarkably high degree of adaptability to the distinct functions that took place there: scientific research, production, logistical support, and administration. The presence of such a well-organised site, with service ramps, internal tracks, and multi-storey scaffolding, reflects the ability to combine speed of execution, technological experimentation, and compliance with strict military regulations. An analysis of the photographs of the site and the design drawings confirms the extent to which aeronautical research influenced the design choices and, at the same time, how the architectural and engineering solutions allowed a degree of avant-garde technical experimentation, providing the Air Force with a fundamental tool for the development and testing of aeronautical technologies (Fig. 17).

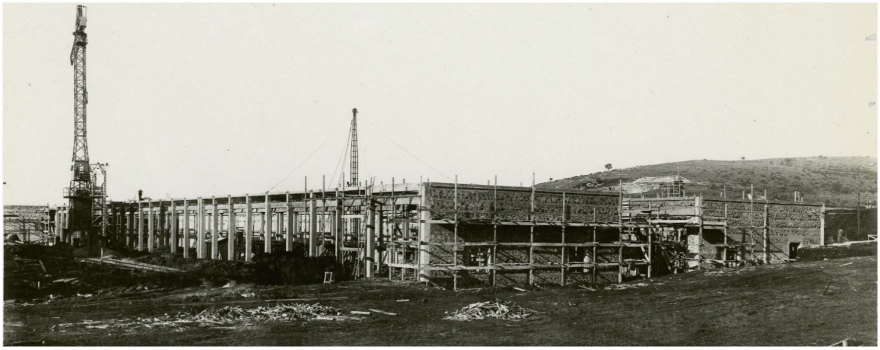

Fig. 17. External view of the D.S.S.E. construction site (fonte: Archivio Centrale dello Stato-Fondo - Archivio degli organi politici e amministrativi dello Stato, fondo- direzione generale del demanio, subfondo - divisione demanio, serie - costruzione aeroporti, fotografie).

4 Conclusions

The Guidonia site is a place where architectural ingenuity and technological innovation have come together to create avant-garde buildings and installations. In this historical context of the transition from traditional to modern systems, the choice to integrate load-bearing masonry structures with reinforced concrete solutions, the use of machinery and the deployment of specialised workers demonstrate the ability to exploit all available resources to meet the needs of research. It was not just a question of building a complex: the site represented the very essence of a project designed to house complex experiments and to endure over time as a place of evolution. The historical documentation analysed shows how the organisation of the work phases, the positioning of the scaffolding, the choice of materials and the planning of the spaces ensured not only the optimal realisation of the artefacts, but also the versatility and durability necessary for them to continue to fully express the function for which they were conceived. In this sense, the development of the site programme proves to be an effective knowledge tool, highlighting the deeper nature of the project: not just a static container, but the concretisation of a place dedicated to experimentation. Looking to the future, the Guidonia complex could continue to play the pioneering role for which it was born, updated according to today's needs, but preserving the extraordinary lesson inherent in its original site. The ability to combine technological breakthroughs, constructive practicality and strategic vision makes the D.S.E. site an important example of how the need to respond to ambitious challenges can lead to architecture that is destined to endure. It is in this balance between architectural tradition and the drive towards modernity that the fascination of a work lives, reminding us that the strength of an artefact lies not only in its materials, but above all in the energy of the ideas that guided its creation.

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