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TOOLS FOR THE KNOWLEDGE OF THE BUILT HERITAGE

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E-mail: info@artecweb.org - tema@artecweb.org

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A PRELIMINARY STUDY FOR THE KNOWLEDGE PROCESS: PIER LUIGI NERVI'S TAORMINA STADIUM

Federico Vecchio, Giuliana Di Mari, Alessandra Renzulli

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Abstract

The article highlights the fragilities of a specific category of 20th-century heritage, namely football stadiums. These architectures are even more vulnerable as they are subject to continuous regulatory and performance adjustments that clash with the building's cultural, historical and technical values. Therefore, there is a need to raise awareness of the protection of these architectural works so that interventions can be carried out that combine technical innovation and heritage conservation.
The paper provides a synthesis of the research conducted on football stadiums designed and built by Pier Luigi Nervi, in collaboration with his son Antonio, in Italy's second half of the 20th century. The analysis was carried out on various levels to grasp their specificities, understand their current state, and make the necessary comparisons to identify a case study for further evaluation. The Taormina stadium is a unicum concerning the others considered, both for its compositional and structural components and for additional vulnerabilities that denote it and, at the same time, constitute an exceptional example. Archive research and field investigations outline this architecture's original characteristics and current state of conservation. This process of anamnesis shows how awareness-raising assumes a fundamental role in assisting the different competencies involved in preserving these assets.

Keywords

Architectural fragility, Concrete degradation, Football stadium, Modern architectural heritage, Pier Luigi Nervi.

Federico Vecchio*
DISEG - Dipartimento di Ingegneria Strutturale, Edile e Geotecnica, Politecnico di Torino, Torino (Italy)

Giuliana Di Mari
DISEG - Dipartimento di Ingegneria Strutturale, Edile e Geotecnica, Politecnico di Torino, Torino (Italy)

Alessandra Renzulli
DISEG - Dipartimento di Ingegneria Strutturale, Edile e Geotecnica, Politecnico di Torino, Torino (Italy)

** Corresponding author:*
e-mail: federico.vecchio@polito.it

1. INTRODUCTION

The various epistemological discussions seem not to deal with the complexity of the very essence of heritage and the most appropriate methodologies for their protection. Cultural heritage appears not to be considered unambiguously, as if there were a dividing line between monuments belonging to Antiquity, which are universally acknowledged and therefore to be protected, and the "other" monuments, which, due to the absence of historical distance and to interpretative difficulties, are subject to judgments of merit on the quality or integrity of being heritage. The need for more safeguarding and the critical issues arising from the buildings' complexity and, consequently, the actions to be taken are added to the discrepancy in the value recognition [1]. Furthermore, it is evident how the mutation of terminology and the indiscriminate use of terms, such as transformation, re-

cycling, and reuse, elude the very meaning of the words conservation and restoration [2] and generate confusion in the purposes of protection and in the tools for identifying and protecting heritage values. Thus, it is noticeable that interventions on existing built heritage are complex actions whose governability is directly proportional to the degree of knowledge and the ability to read the built environment to reunite the asset with the values it carries.

In twentieth-century architecture, the close distance between the authors of the work and the authors of the intervention allows for design possibilities that also presuppose, in some cases, the posthumous execution of incomplete parts or the restoration to their original form for those parts that have deteriorated. This fragility is directly related to the material, making the interventions in architectures realized through technological innovation particularly complicated. Their experimental character has often been betrayed by time, leading to the rapid deterioration of these new materials. This heritage has been «neglected by Italian legislation» [3] and is treated in the same way as coeval buildings, for which interventions are carried out to meet firstly current conformity requirements. In addition, the amendments to the Codice dei Beni Culturali e del Paesaggio with the Italian Decree Law 70/2011 shifted the time constraint from fifty years to seventy years, exposing much of the heritage of the Modern to compromise further. The fragmentation of the unity of heritage is also evident in the case of sports facilities. The ratification of Article 55 bis of the Italian Law Decree 76/2020 – known as the "sblocca-stadi" amendment – acts as a backlash to many of the articles of the Italian Legislative Decree 42/2004 and Article 9 of the Constitution itself, allowing exceptions to the safeguard procedures. What emerges is the lack of a total and general vision of the national cultural heritage and the dangers to which it may be subjected, admitting exceptions to the basic principles of protection with consequent threats of widespread demolition and denaturalization.

The emblematic incident of the Artemio Franchi stadium – formerly Giovanni Berta – in Florence highlights the fragilities that characterize the specific category of sports facilities. Since 2020, the stadium has been, and still is, the protagonist of a controversy that began with the hypothesis of its transformation – with the possibility of extensive demolition – raising the alarm on how cultural heritage should be managed. The function of these architectures is crucial in their survival and risk of compromising their testimonial value. Constantly updated compliance requirements often justify intervening with radical transformations or decommissioning iconic structures that can no longer meet economic and management needs. When abandonment occurs, the size of these structures makes it even more challenging to identify functions other than the original ones, inevitably leading to demolition or abandonment and, thus, degradation. In Florence's case, the recognition of this architecture as a masterpiece and the authorship of Pier Luigi Nervi's project do not imply greater attention to protection; on the contrary, the administrations have entirely ignored these values. The same happened with the Fla-

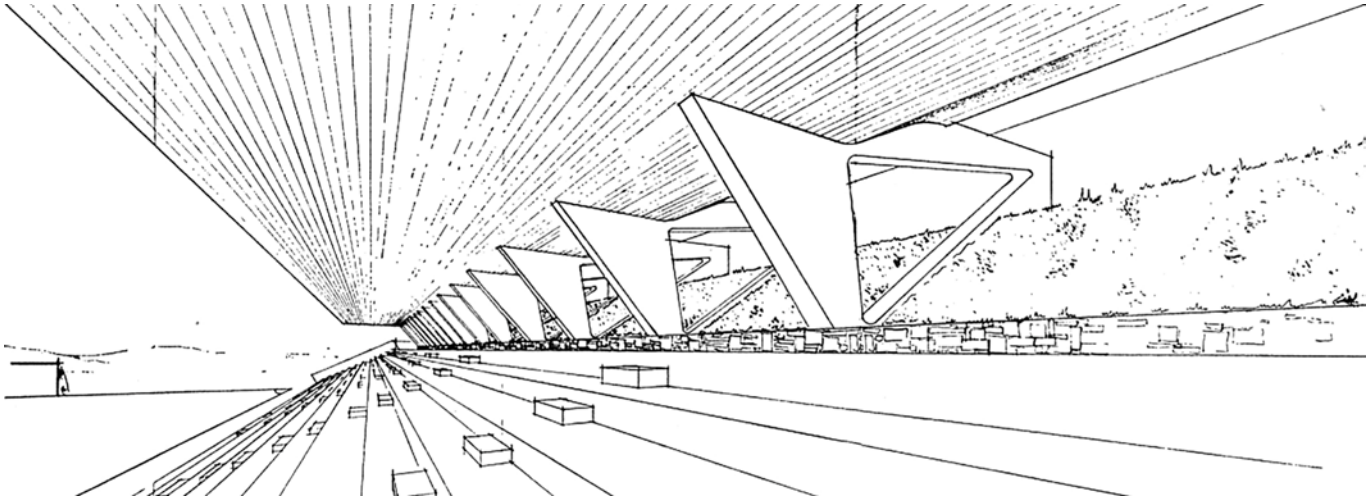

Fig. 1. *Sketch of the Taormina Stadium. Source: © 1958, Architectural Record 12.*

minio stadium in Rome, decommissioned between 2011 and 2012 and still awaiting a valid restoration project. In 2017, a Conservation Plan was drawn up and financed by the Getty Foundation as part of the "Keeping It Modern" program [4]. This also led to its preservation and revealed the severe state of decay in which the stadium finds itself due to the improper interventions carried out on some parts of its structures. Concerning the other stadiums designed and built by Pier Luigi Nervi in Novara and Taormina (Fig. 1), the paternity of the former has been attributed exclusively to his son Antonio, while the latter is often not considered among Nervi's works and also for this reason almost entirely unknown.

2. METHOD

The research focuses on stadiums designed by Pier Luigi Nervi. The stadiums were built during the post-World War II period in the context of the Italian engineering sector, which was characterized by a new architectural language made of innovation and experimentation on reinforced concrete systems. The construction manifested the constraints from the previous autarkic period when the choice of materials was linked to the need to use only national products. Steel had to be used moderately, making it necessary to optimize the structures. The reduction of reinforcing bars, structural weights, and resistant sections, as well as the use of the arch to realize large spans persisted even later, representing the architecture of the years of the Italian economic miracle.

The Italian engineering sector assumed a leading role due to Pier Luigi Nervi, who could perceive the correspondence between structure and form through its manifestation in reinforced concrete. His first internationally acclaimed work, the Berta Stadium in Florence, represented a curved structure shaped by the masterly use of its material. In the second half of the century, Nervi conceived a new way of building that would later become an authentic style, a system capable of being aesthetically, economically, and temporally practical simultaneously. Eliminating the wooden formwork and reducing the thickness of the elements to limit the use of material, the originality of Nervi's system is expressed in the organization of the construction area divided into parts on-site where the skeleton of the architecture – excavations, foundations, pillars – is built. Another characteristic of prefabrication is that it creates all the elements that, when assembled, recompose the structure into a monolithic structure. In football stadiums, Nervi applies his way of «building correctly» [5], bringing out his *modus operandi* in synthesizing technique and aesthetics. Giuseppe Perugini defined this binomial as «form-structure» [6], where the term structure is identified and associated with the concept of functionality [5]. This binomial finds a practical application in sports facilities as buildings determined by the decisive role of design. Form, technique, and function are interconnected and discovered through the construction possibilities offered by reinforced concrete.

The analysis was conducted starting from the protection and preservation systems inherent in the designs of three stadiums signed by Nervi (Fig. 2): the sports center stadium in Taormina (1955-1960), the Flaminio stadium in Rome (1956-1959) and the municipal stadium in Novara (1964-1976). After the famous Berta municipal stadium in Florence, these stadiums resulted from the collaboration with his son Antonio, with whom he founded the Studio Nervi in 1954 to join the Nervi & Bartolini design studio. These are typologically innovative sports facilities, where a significant role is taken by technical and structural achievement and with particular attention to aesthetic expression [7]. The Florence Stadium, even if it was mentioned at the starting point for the discussion, is not included in the study as it is: chronologically earlier, designed by Pier Luigi Nervi without the collaboration of Antonio, and extensively covered with the discussions on the dangers of demolition.

The three stadiums have been investigated by defining categories of analysis, which are necessary to understand the complexity of the individual architectures and compare them. For example, in addition to the year of construction and the authors, the following are also considered: the competition announcement and the constraints imposed by the client; the project and the location; the planimetric configuration, including the capacity and the compositional characteristics; the structural choices, embracing the prefabricated elements designed; the development of the construction site; and the current state of conservation and degradation. In the case of the Flami-

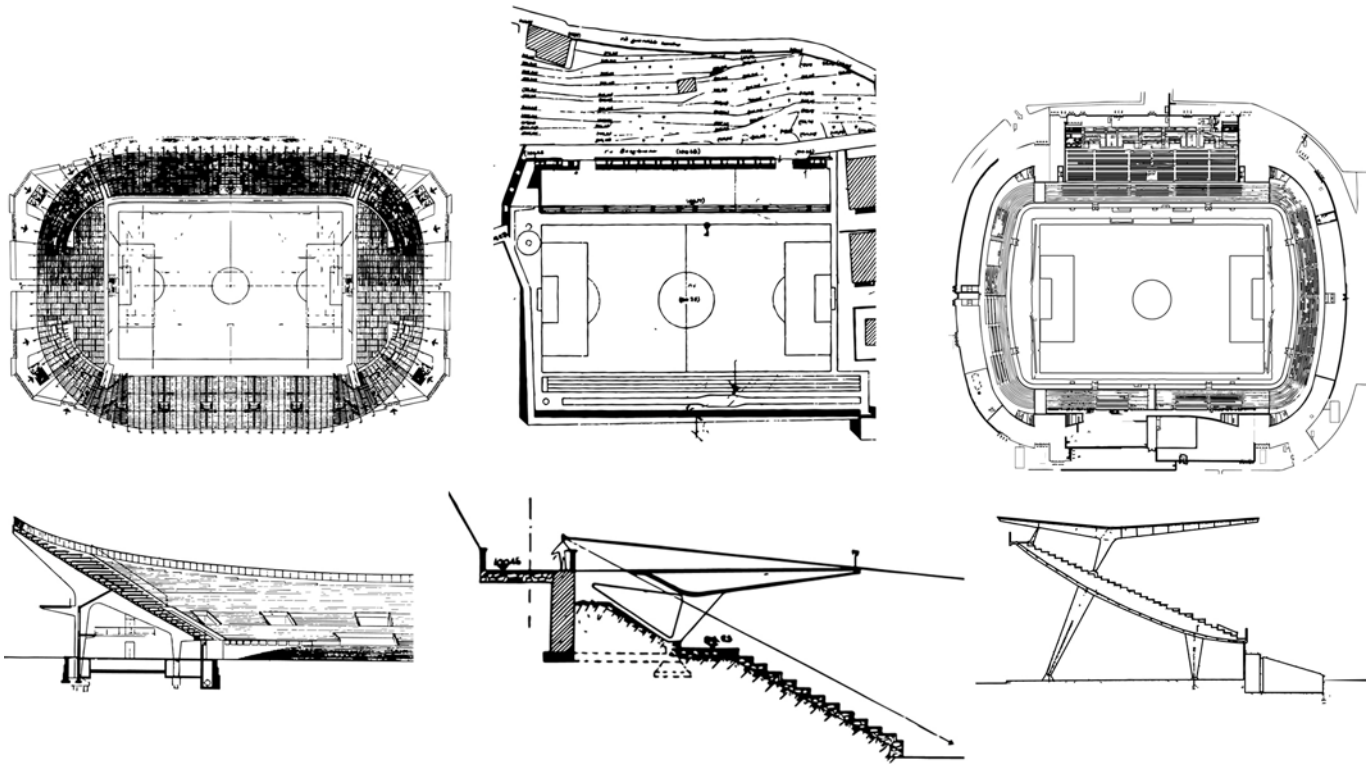

Fig. 2. *Sketch of plans and sections of the three Nervi stadiums in Rome (left), Taormina (center), and Novara (right). Source: © 2024, drawing by the Authors.*

nio stadium in Rome, the characteristics of the asset were recognized and protected thanks to the joint action between the Municipality of Rome, Sapienza Università di Roma, Pier Luigi Nervi Project Foundation and Do.Co.Mo.Mo. Italia with the support of the Getty Foundation. To date, the stadium is in a state of neglect. It is particularly subject to degradation – due to decommissioning and the physiological aging of materials and equipment – although a conservation plan and restoration project have been drawn up, which still need to be implemented. In the case of Novara, the football club announced a competition to construct a new multi-purpose stadium; the Andra Maffei Architects studio, the competition's winner, proposed an *ex novo* project, keeping the west part standing as the only original element. The Taormina stadium is still partly used by the local football club. It is in a limited state of decay and has not been subjected to any interventions, so it was chosen as the object of the following investigation. The case study analysis was conducted through an anamnesis of the archival documentation and an on-site inspection based on Coppola and Buoso's methodology. In particular, this methodology identifies the objectives to be pursued when undertaking maintenance work on reinforced concrete structures. These are general objectives regarding restoring structural safety, use function, and aesthetics, and specific objectives regarding degradation mechanisms [8].

2.1. PRELIMINARY ANALYSIS

The Flaminio stadium represents the first outcome of the change in Pier Luigi Nervi's professional activity. The stadium was built for the 1960 Rome Olympics, replacing Marcello Piacentini's previous National Stadium (1911). The pre-existence became a condition of constraint in the call for tenders: to fit into the tight time schedule – given by the demolition time of the pre-existence (between July 1957 and December 1958) and the construction site (within the following 18 months) – and to preserve the playing field and not to move out of the original area, it was unfeasible to adopt a totally "crescent" shape [9]. Thus, Nervi designed a ring-shaped grandstand surrounding the playing field to centralize the considerable number of seats on the straights corresponding to the field's length. The seats are standing and seating, the latter uncovered and covered. In particular,

the covered seats are protected by a cantilever roof to the west. A further constraint of the competition notice was the realization of autonomous services. The swimming pool and gyms for boxing, weightlifting, and heavy athletics were built on the lower level of the west straight; gyms for gymnastics and fencing were constructed below the east straight [10]. The public's accessibility to the grandstands is guaranteed by two pincer staircases that disengage the café and toilets and the cantilevered external galleries: the last ones were built to provide easier distribution of spectators to the various *vomitoria*. Independent entrances are designed to welcome the authorities. From a structural point of view, Nervi proposed a solution with ninety-two reinforced concrete frames with two hinges and a center-to-center distance of 5.70 m, whose section has a constant shape and adapts to the various multi-purpose areas, varying in height and width over the entire curvilinear field. In addition, innovative technical experimentation allowed for the construction of the bleachers and the cantilever roof of the west stand with prefabricated reinforced concrete elements. The frame of the stadium's load-bearing structure, which has no cladding or plaster and is realized through wooden formwork composed of planed and tapped staves, is connected by secondary ribs and the prefabricated structures of the bleachers. The site was developed in two autonomous, parallel locations: in the first, *in situ*, the foundations in Frankie piles (length: 10 m; ϕ: 55 and 35 with load-bearing capacities of 90 and 55 tonnes), and the structural frames were cast; in the second, in a neighboring area, the prefabricated elements were built and then gradually assembled on-site. This process synthesizes technical solutions capable of building quickly and economically, thanks to the elimination of the wooden formwork for the prefabricated elements and the reduction of the thickness of the resistant aspects, permitting the containment of material costs [11].

Simultaneously, in those years, Nervi designed and supervised the construction of the Taormina stadium. Smaller in size than the Flaminio, it was a facility resulting from the administration's need to build a new stadium in the area of the old playing field. The main constraints were related to the small total surface area and the inclusion of the facility within a highly characterizing historical landscape context. In this regard, Nervi combines respect for the existing context with structural components with innovation, and this integration represents a distinctive expression of Nervi's innovative vision in architecture and engineering. From a compositional point of view, the football pitch is flanked to the north and northeast (seaside) by the athletics track and a tiered seating area cantilevered from the retaining wall. Two covered bleachers above the south grandstand have been placed on the opposite side (street side), accommodating both standing and seating. These seats were designed below street level to create a viewing terrace above the canopy, providing additional space for the overflow spectators. It was designed and built to open up the view of the playing field and the surrounding landscape for spectators while sheltering under the covering – thanks to the reduced size of the front grandstand – and for anyone standing on the viewing terrace. The sports facility adapts to the terrain, and the bleachers on the side opposite the sea make the landscape a theatrical backdrop [12]. Finally, the respect for the context was also manifested by the choice to use local materials – grey stone – for the cladding [13]. From a structural point of view, this cantilevered square was created using the technical and technological innovation applied to the reinforced concrete canopy. The section has a curved slab resting on eighteen triangular cantilevered brackets of 8.50 m (placed with a 5.7 m spacing) resting on pillars that intersect in the ground, where each frame is connected at the rear to the retaining wall. Thus, it provided for the creation of a balanced system, avoiding tipping over towards the valley. The ceiling is an overall volume consisting of two parts: an upper part in reinforced concrete and bricks that extend over a large part of the carport and a remaining part built only in reinforced concrete. The canopy is 3.5 m away from the rear wall. In 1955, the Nervi studio integrated an expansion joint in the structural part and four shelf beams inserted in the curvilinear part of the interpreted slab to interrupt the critical length of the long side, avoiding modifying the frame section and the original design [14].

The last stadium, dating back to the 1970s, is in Novara. The contract was awarded by Nervi & Bartolini design studio through an invitation-only tender. Studio Nervi & Bartolini designed the project to replace

Fig. 3. *The Nervi's skills emerges between fragility and degradation. Source: © 2021, Authors.*

the existing stadium to maximize the available space. The plan was more linear and pragmatic to permit the possible expansions, as was in the Rome stadium: the non-use of the crescent solution allowed for additional grandstands positioned above the existing ones, offering greater flexibility in the design and expansion of the stadium [15]. This sports facility has a symmetrical rectangular plan with two straights along the length, housing the covered and uncovered stands, and two curves along the width with the remaining seats. Nervi designed the structure with economy and compositional harmony, placing the curves on a gravel layer and ensuring the contrast between the turf and the reinforced concrete walls was attractive. Above the straights made of a concrete slab, the inclined grandstands were located at the highest point (10.50 m). These consist of a repetition of reinforced concrete trestle frames lying on an inclined beam, curved in the intrados and with steps cast *in situ* on the extrados, where the seats rest. Both the inclined beams and the seats are made of prefabricated elements. Two pillars support the beam, an inner one on the field side and an outer one at the highest point. Thanks to prefabricated elements, the configuration of these frames, determined by static requirements, is easily repeatable. As in the Flaminio stadium case, there are dedicated spaces below the stands – changing rooms, toilets, and two gyms – and external pincer staircases and walkways to access the rooms. A grit finish was planned for the cladding, which was not realized because it was considered redundant.

The three stadiums analyzed represent architectural *unicum*, where Nervi's signature is evident in all structures. As illustrated in the following table, the comparison between the three stadiums highlights how the Taormina stadium is an isolated case compared to the other two: in fact, the design of the Novara stadium is more easily comparable with the Flaminio in terms of design choices, such as the presence of a similar subdivision between the grandstand and the parterre, but also for some of the technical solutions mentioned above. The substantial difference is noticeable not only from a compositional point of view – with a plan that is more rectangular than ring-shaped – but also from a structural point of view, evident in the compositions of beams, pillars and frames.

3. RESULTS

In the case of Taormina, there are further specific vulnerabilities (Fig. 3) characteristic of football stadiums, in addition to the criticalities typical of the Modern heritage. Several reasons lead to assimilating the stadium into a minor work [16]. The first is that, compared to the stadiums in Rome and Novara, it is smaller in size, designed to hold up to a maximum of 3,900 spectators (Tab. 1). The second is that this stadium has been little studied and, at times, excluded from the scientific literature, being the subject of interest only of authors Antonino Marino and Laura Marino [14]. A third reason is the lack of interest in heritage protection from organizations and associations.

	Stadium of Rome	*Stadium of Taormina*	*Stadium of Novara*
Year of construction	1959	1960	1976
Authors	Pier Luigi e Antonio Nervi	Pier Luigi e Antonio Nervi	Pier Luigi e Antonio Nervi
Project constraints imposed	- Preserving the field - Respect the area of occupation of the previous stadium - Tight deadlines for the demolition of the old stadium (18 months) and the closure of the construction site (18 months)	- Respect the area of occupation of the previous stadium - Respect the landscape	- Respect the area of occupation of the previous stadium
Projected seats	42000	3900	25000
Planimetry (Fig. 2)	Ring implant without *crescent* shape, athletics tracks and possible expansions	Two-straight track associated with a theatre with athletics tracks (on the long north-north-east side) and grandstand (on the opposite side)	Rectangular layout based on two straights and two curves without *crescent* shape
Compositional characteristics	Presence under the stands of a lower floor with swimming pool, gyms (boxing, weightlifting, heavy athletics, gymnastics and fencing) and service rooms	- Openness to the landscape - Rooftop open square in case of surplus - Dual view for spectators (panoramic and field view)	Presence under the stands of a lower floor with two gymnasiums and service rooms
Structural section	92 frames with non-repeatable 2 hinges (constant shape, variation in height and width)	18 triangular brackets on which the curved floor of the canopy rests	Repeatable gantry frames
Shelter	Cantilevered roof positioned on the grandstand	Cantilevered roof positioned on the grandstand and square open to the landscape	Cantilevered roof positioned on the grandstand
Stairs	Pincer exteriors with cantilevered balconies	Integrated into the grandstand	Pincer exteriors with cantilevered balconies
Main finishing	Exposed concrete	Exposed concrete	Exposed concrete
Prefabricated elements	- Roof - Stands	- Roof	- Seats - Soffit inclined beam of structural frames
Construction site	Developed in two parts	Developed in one part	Developed in two parts
Actual state (2024)	Abandoned and subject to severe degradation	Partially functional and prone to degradation	New project in progress

Tab. 1. *Comparison of the three Italian stadiums analyzed by Pier Luigi and Antonio Nervi. Source: © 2024, Authors.*

Among them, it's worth mentioning the absence of this stadium on the portal of the Pier Luigi Nervi Project Foundation, dealing with preserving the patrimonial memory of Nervi's works. This knowledge gap also impacts the local community, which needs to be aware of its values and recognize it as heritage. The stadium cannot be visited and is not indicated on any itinerary. Moreover, its use for sporting purposes is restricted to the local amateur football club, whose limited availability of funds does not guarantee its adequate management and maintenance. The only project concerning the stadium's maintenance was in 2023, funded by the National Recovery and Resilience Plan, for resurfacing synthetic turf and the energy efficiency of the facilities (Unique Project Code: E84H22000500001). Also, the Taormina stadium must still reach the seventy-year Legislative Decree 42/2004 protection bond requirement. The area where it stands – classified as an "F3 Sports Zone" – has hydrogeological, geomorphological, and seismic risk level 2 restrictions. The absence of constraints or protection can be dangerous, especially when considering an intervention that does not take the form of restoration since any action is left to the sole sensitivity of the designers. Consequently, the stadium is subject to potential risks of alterations that could compromise its value transmission. Nervi was aware that the architecture of the time would not withstand five hundred years [17] and therefore questioned the durability of materials, particularly the resistance of reinforced concrete to thermal expansion. Aware of the critical issues related to the construction system, the engineer put in place solutions – for example, the need to keep the steel of the concrete

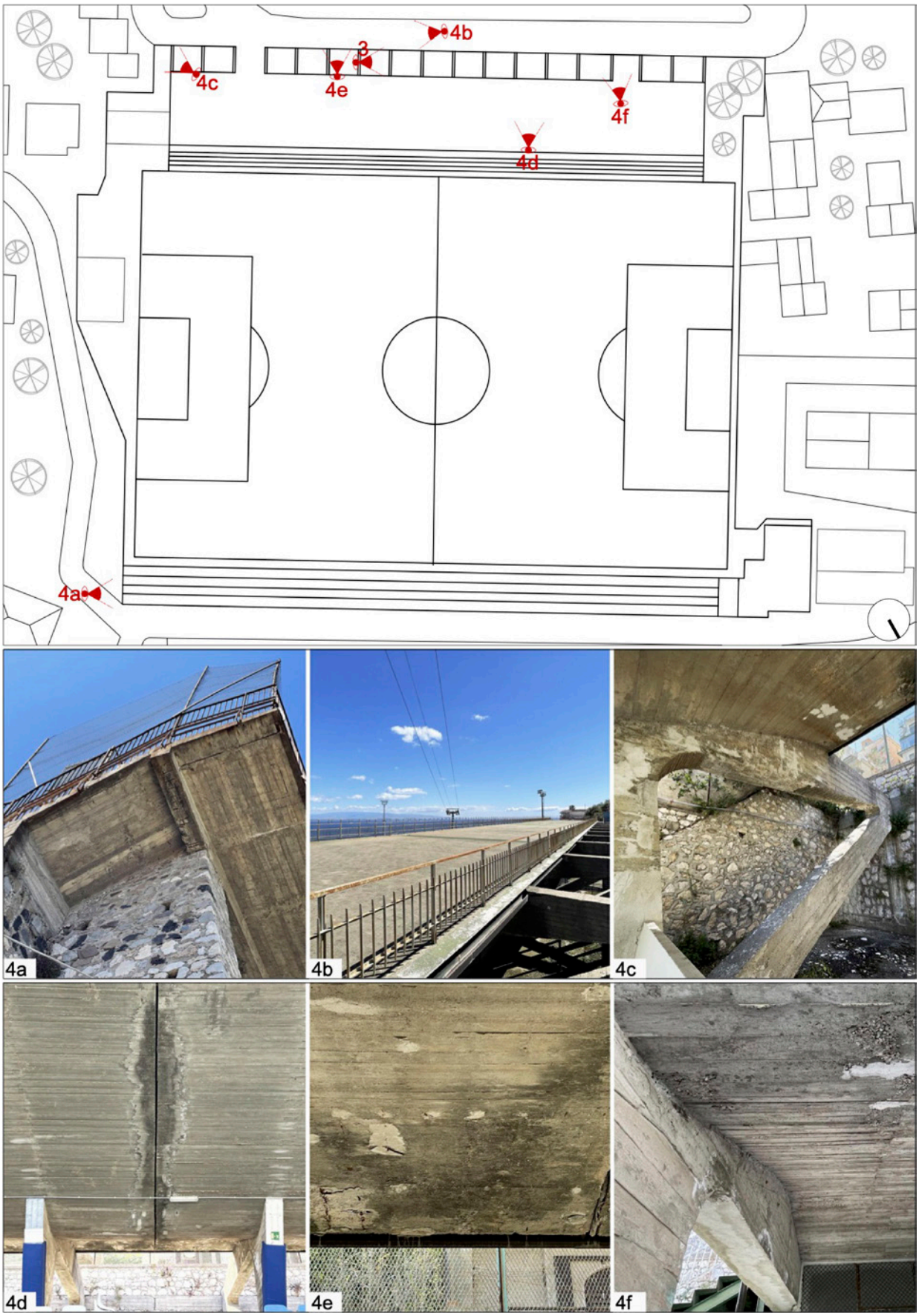

Fig. 4. *Details of the degradation and location in the floor plan: (a) the north stand in structural decay, (b) the abandoned terrace, (c) aesthetic degradation from incorrect patching and vegetation, (d) degradation at the structural joint, (e) lack of concrete and spalling, (f) construction defects such as honeycombs. Source: © 2021, Authors.*

reinforcements away from the external surface – which kept the Taormina stadium in a reasonable state of preservation, beyond the widespread degradation due to aging and lack of maintenance plans.

In April 2021, an on-site inspection was conducted to study the actual state of the stadium, and it appeared to be in good condition from a structural point of view. However, it presented criticalities that prevented its use during the survey. The following description of the detected pathologies is referred to the Italian standard UNI 11182:2006 Beni Culturali (former Normal 1/88 ICR-CNR).

The north stand is cantilevered and has reduced thickness (Fig. 4a), which shows damage due to pull-out phenomena that expose the reinforcement bars and have caused cracks and localized corrosion decay. In addition, it shows significant degradation due to increased exposure to weathering. The south grandstand presents problems that also impact the functional aspect: the terrace above the roof cannot be used for the heavily degraded flooring and the corroded metal parapets (Fig. 4b). Other problems are related to poor or inadequate maintenance, such as weed vegetation and inconsistent patching with cement mortars (Fig. 4c). Problems related to water exposure have caused efflorescence, discoloration, delamination, and cracking, particularly at the three structural joints of the south stand roof (Fig. 4d). In several places, material *lacunae* and small localized spalling phenomena are also evident where the ceiling reinforcement cover is thinner (Fig. 4e). Finally, sporadic honeycombs are evident (Fig. 4f). All of these elements contribute to an evolving cracking and degradation process that, over time, could alter the very stability of the structure. The sports facility generally does not meet regulatory requirements regarding fire prevention and removing architectural barriers.

This study aimed to highlight an architecture largely unknown to date that reveals features of patrimonial value that are not manifest. The anamnesis of the building's history was possible thanks to the consultation of archive material kept at the technical office of the municipality of Taormina. The comparison between the current state of the stadium and the executive drawings in the archives, the technical reports, the sheets of materials used, and the correspondence between those in charge of the project made it possible to reconstruct an accurate knowledge of the property. The inspection allowed a preliminary mapping of the degradation present and is configured as a first step for a future detailed survey, through which non-destructive testing (NDT) will be carried out to assess the residual helpful life [18]. Subsequently, collecting all the data will permit the evaluation of suitable interventions within the framework of conservative restoration.

4. CONCLUSIONS

The Taormina case is emblematic as it illustrates the many fragilities that can characterize sports facilities. To this day, the Sicilian stadium partially maintains its function. Despite this, it highlights problems, offering the possibility to reflect on feasible restoration projects that can emphasize the work's valuable qualities and allow for adequate maintenance work. Knowledge of conservation also assumes an understanding of the concept of heritage and its recognition. Therefore, it is essential to contemplate further the performance adjustment defined in the current regulations when dealing with components that lack the initial evaluation phase, as discussed by Bardelli [19]. Design interventions should be guided by greater attention to the phase of historical-material knowledge of the building. This guarantees an understanding of the cultural heritage and leads to value recognition and, therefore, to subsequent protection, even when not linked to a binding regime. The Taormina stadium shows fragility, which is evident in the widespread lack of recognition of Pier Luigi Nervi's work. In the case of Novara, this oversight extends to the misattribution of the project's authorship solely to his son Antonio, with no mention of Pier Luigi Nervi. Conversely, the definitive identification of the designer behind the Flaminio stadium has significantly contributed to the building's recent protected status. However, there are still many challenges related to its restoration. This study aimed to initiate a knowledge process that could be the base for future interventions concerning the Taormina stadium. Identifying additional vulnerabilities resulted in its classification as minor work, leaving the Sicilian sports facility even more susceptible to risk than the others under consider-

ation. In this context, the words of Dezzi Bardeschi, «not only to know to conserve but also to conserve to know» [20], are highly pertinent for the preservation of this architectural typology. These words aimed to raise awareness among public administrations and the community by exploring viable solutions through scientific research. By acknowledging the value of the work, scholars can initiate processes that increase consciousness within the local community. This plays a crucial role in addressing the challenges associated with restoring the most fragile buildings, which are still unresolved today. It emphasizes the necessity for a "case-by-case" approach to intervene based on the specificities of each of these architectural structures. Collaboration among experts is essential to uncover all relevant characteristics through research and harmonize strategies with stakeholders to preserve and transmit the heritage to future generations.

Authors contribution

Conceptualization, F.V.; Methodology, A.R.; Investigation, G.D.M.; Writing – Original Draft Preparation, G.D.M.; Writing – Review & Editing, F.V. and A.R.; Visualization, G.D.M. and A.R.

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