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MOLINO PALOMBA - DEGRADATION AND POSSIBLE STATIC RECOVERY OF A DISUSED INDUSTRIAL BUILDING

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ABSTRACT

The aim of this paper is to propose an intervention methodology for the restoration of an industrial archeology building starting from the analysis of the state of the art with a view to sustainability and resilient thinking. The building in object is an ancient masonry mill called "ex Molino Palomba" that has, in the writers 'opinion, historical-monumental relevance both as a symbol of ancient work technologies, that because is situated in a territory strictly interconnected with the "Caserta Palace" (UNESCO site). Today the building presents a visible state of decay and structural instability, but a preliminary analysis of the overall framework and the bibliographical research, have however allowed to outline a proposal of a resilient approach.

Key words: Masonry, Insustrial Archeology, Degradation, Structural Instability, Structural Restoration, Resilience.

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1. INTRODUCTION

The need to protect and preserve the monumental heritage well as the need to reduce and control the growing phenomenon of land consumption, require increasing attention to the recovery and reuse strategies of the buildings. An holistic and transdisciplinary approach on the subject can be to make sustainable choices where the "constructed" is itself a resource to be protected from several points of view [1]. This should not be understood as a simple desire to reuse what already exists, but as "building the present on the past, without mortgaging the future, joining them without destroying them both" (A. Sartoris). To achieve this, we have to enhance and promote the knowledge of the historical features of our territories. It is within this journey that the reuse of industrial archeology buildings represents an unmissable opportunity for building recovery, through the exploitation of what they represent and testify. This cannot and must not be limited only to assessments regarding the seismic vulnerability and the restoration of technological and architectural features. It is necessary to implement a resilient intervention strategy to ensure the maximization of performance while minimizing the impacts. Resilient thinking goes beyond the concept of sustainability as it allows us to determine whether a system of transformations overcomes a negative event in a "more sustainable" way than others [2,3]. In the last decades the modern investigation techniques and structural analysis methods as well as the development of new materials, allow getting the right approach to the problem [4,5,6,7,8,9,10]. It is proposed to follow an intervention methodology for the case study of the "Ex Molino Palomba" industrial archeology building located in the municipality of San Nicola La Strada in the province of Caserta.

2. EX MOLINO PALOMBA

The building named "Ex Molino Palomba” is located in San Nicola la Strada, a town that covers 470 hectares very close to the Royal Palace of Caserta (fig. 1) and situated a few kilometers away from Naples.

Figure. 1. Map includes territory between the Molino and the Royal Palace of Caserta

San Nicola La Strada is located in the territory of the Caserta plain that constitutes, together with the SS87, road a complex architectural landscape where the building at issue is located (fig. 2).

Figure 2 Location of the case study in the city area

The building expansion, since the beginning of the twentieth century, was characterized by the use of tuff. The "Ex Molino and Pastificio Palomba" (fig. 3), best known as "Pastificio Fisone", is included in a larger historical building complex. The Molino was built in 1823, commissioned by a Neapolitan industrialist who opposed the Bourbon power and settled in the municipality of San Nicola la Strada. He gave testimony of the liberal-masonic power that broke the local agricultural tradition. In 1908 in consequence of the war, with the abandonment of its original intended use, the building was affected by a slow process of degradation due to the absence of maintenance interventions. The Molino became the base of the Army during World War II at first and then was the headquarters of the Caserta Police in the following decades taking the name of “Casermette”. In 1983 it was taken into custody by the Municipality Authority, losing his nickname.

Figure 3 The building “Ex Molino Palomba” today

2.1. The Structure

The building covers an area of 2460 square meters and is developed on three levels above ground for a total of 30,000 cubic meters. It's characterized by a central courtyard of 527 square meters: it's bordered by a large courtyard to the north and east, by a covered porch and a surrounding wall to the north and west and by a garden to the south. It was complicated carrying out detailed reliefs due to the deep state of decay which affects the whole area (fig. 4).

Figure 4 (a) and (b). The current deterioration of the building

The inner area of the ground floor was originally used as a warehouse and factory; the upper floors were used for the private homes of the founding family. On the private floors, the building has decorated arches and presents ancient wallpapers that cover the walls and the remains of false ceilings; these elements reduce the height of the rooms from the original 4.20 meters to the current 3.50 meters.

The plan shows an irregular geometry (fig. 5, 6).

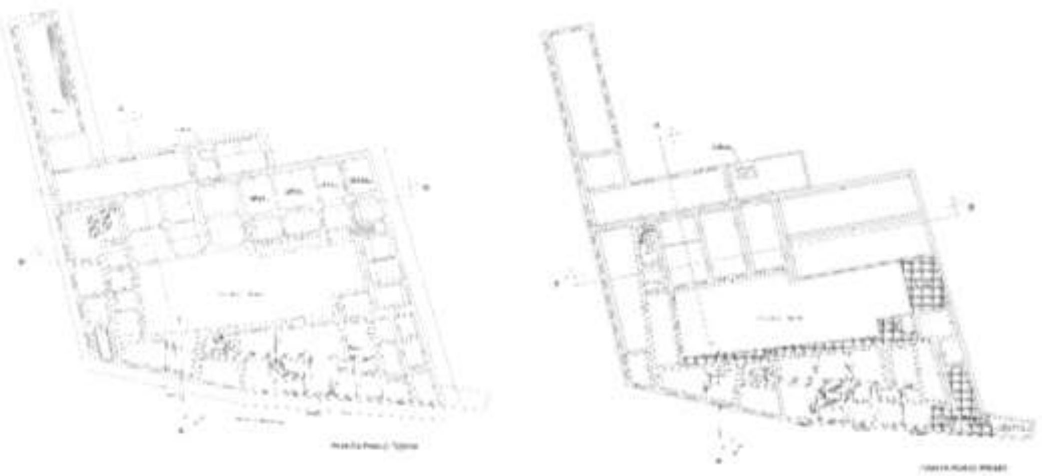

Figure 5 (a). Ground floor plan; (b) First floor plan

Figure 6. Second floor plan

The three levels above ground have a height of 13.30 meters, of which: 4.70 m on the first level; 4.50 meters on the second level and finally 4.10 meters for the third (fig. 7-10)

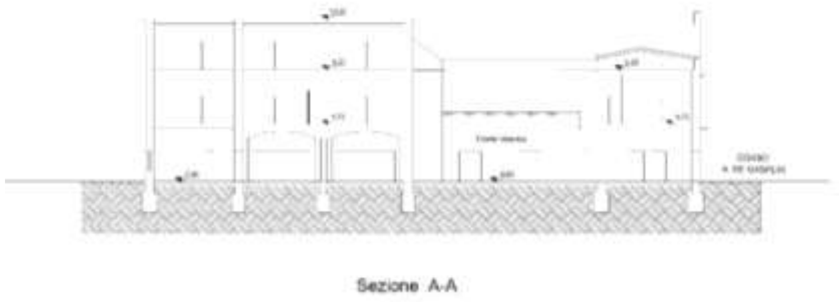

Figure 7. Section AA

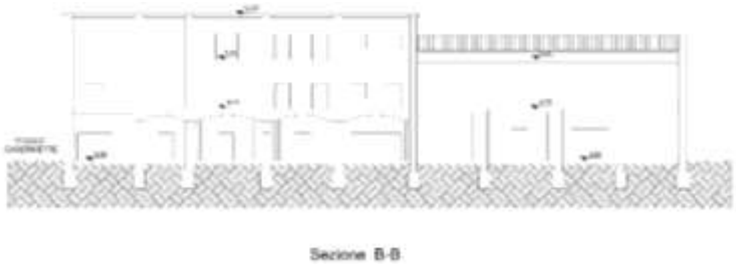

Figure 8. Section BB

The masonry is in tuff, the load-bearing element of the whole structure. It has an internal thickness of 70cm for the ground floor and 50cm for the next two.

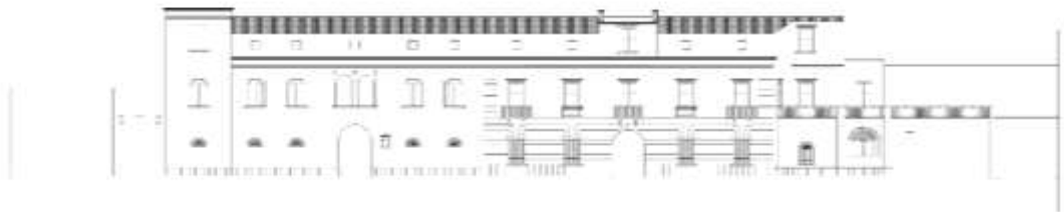

Figure 9. South front

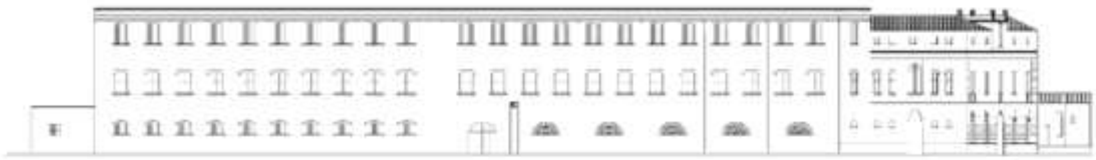

Figure 10. West front

The slabs are of different kinds:

- On the ground level there are both timber than iron floors; there are moreover stone vaults, and in detail ribbed, cross, and barrel vaults, all with a key height of 4 meters;
- On the first floor: the carpentry is homogeneous with wooden floors;
- On the second floor: uneven, between iron floors and tile roofs (fig. 11). The tiled roof is present in greater numbers throughout the building, with a double warp of wooden beams 2.05 meters from the floor. The production body has flat iron floors, waterproofed with bitumen.

Figure 11. Roof plan plan

3. BUILDING DEGRADATION

Most of the wooden floors have collapsed (the "survivors" are in the area used as a private residence) (fig. 12 a). The structure has walls 13 meters high and up to 11 meters apart. This describes an advanced state of structural degradation. What remains intact is the iron elements of the slabs, despite being rusty (fig. 12 b). The walls, however, do not show signs of serious subsidence: the cracks were found in small isolated portions of the tuff masonry.

Figure 12 (a). Collapsed wooden floor; (b) Rusty iron

Visible issues concern the plaster, false ceilings (fig. 13), and stairs (fig. 14). For the rest, the general state of deterioration is strongly connected to the presence of weeds and efflorescence that caused cracks in masonry. The building presents moreover degradation phenomena due to the extended exposition to the weather.

Figure 13 (a) and (b). Degraded plaster and false ceiling

Figure 14 (a) and (b). Collapsed stairs

As for the wooden floors, the authors verified that it is possible to hypothesize recovery and stiffening interventions that do not overturn their significant aspects [11] imagining the slab reconstruction (in a modern key) with homogeneous materials.

3.1. Structural Issues

Despite the long neglecting period and several tampering, the building does not present significant elements of static instability. The tuff masonry is compact, even as the different layers of mortar. The greatest degradation is attributable to floors both for timber that iron ones. To realize an effective intervention for the wooden elements an accurate investigation campaign will be required to decide which elements have to be replaced and which repaired and or reusable. The iron floors are deeply degraded and present a high degree of corrosion, there are therefore depressions and irreparable failures. The structural elements cross section is significantly reduced and follows the lower bearing capacity and lower bending resistance. Structural inefficiency of the floors determines a higher freestanding length of masonry walls: in the absence of decks walls have a maximum height of inflection (equal to the sum of those of each single order). The walls do not cooperate under the action of horizontal forces, or in the event of an earthquake. The global masses are not correctly distributed among the vertical structures due to the lack of coupling masonry beams, so the walls behave as if they were shelves. This results in the "artichoke" opening of the walls with consequent definitive collapse of the entire structure, or it would generate an overturning towards the outside (fig. 15).

Figure 15 (a) Non-box-like behavior of the structure without decks in the event of an earthquake; (b) Simple tipping mechanism; (c). Reversal of the cantonal.

It was detected three orders of damaging:

- In the first one the crack pattern doesn't show visible and excessive cracks. Only partially on the architrave.
- In the second one, the walls present widespread damage and secondary collapses.
- In the third one, the cracks are significant in the architraves, in the hammers and cantons, and in the overhanging areas of the load-bearing wall.

What would most have caused the instability phenomena listed above would be the shortcomings of the decks and the age of the walls themselves. Other causes are the crushing phenomena and the exceeding of critical shear stresses.

Any visible subsidence wasn't detected, follows we can hypothesis that there aren't problems in foundations. It's clear that this hypothesis shall be validated by accurate investigations.

4. RESTORATION METHODOLOGICAL PROPOSAL

The methodology proposed in this chapter aims to offer insights on the possibility of implementing a retrofit strategy with a view to resilient thinking. This approach is strictly connected to the evaluation of the life cycle of the intervention as a whole. This represents an evaluation "cradle-to-crave" of the impacts that each action carried out can generate. In each phase of the design, there is the need to face every aspect of the restoration: the structural one, the energy one, the urban planning one. This in order to guarantee the system a dynamic response to negative events affecting the structure or the functionality of the building itself [12,13,14,15,16,17,18,19,20].

To achieve this, an in-depth knowledge aimed at obtaining quantitative information (mechanical properties of the elements, degradation, foundations, etc.) and qualitative (bibliographic analysis and existing and potential relationship with the territory) cannot be ignored. This step is necessary to determine the possible new intended uses and to avoid the "cathedral in the desert" phenomenon that often derives from the realization of interventions that are completely decontextualized and disconnected with the territory of belonging. This condition would determine a progressive state of neglect of the building and the failure of the intervention itself.

For the case of study it can be hypothesized the following quantitative aspects to be evaluated:

- The state of degradation of the single load-bearing elements of slabs and roof, both wooden than iron ones.
- The real masonry consistency both for the resistance of the tuff blocks and for the mortars to be studied as part of their development over time
- The presence of cracks that could lead to the hypothesis of subsidence of the seabed and / or detachment due to the lack of suitable connections.

The path of knowledge is the foundation to determine the guidelines for the restoration project. While respecting the original features the structural schemes and the constituent materials [21,22], functions compatible with the structure, and with the territory can be hypothesized. Nowadays, modern technologies and new structural materials allow a wide selection of materials and construction techniques. The intervention choice is normally made according to the logic of structural efficiency and budget control, but this is not enough in the opinion of the writers. The long-term effects of interventions need to be considered also in terms of durability, reversibility, and sustainability. Only this type of approach ensures that if occurs a harmful event such as an earthquake, the implemented system is able to respond in an adaptive and dynamic way. Therefore, if a low level of damage is required of the reinforced structure, it will be useful at the same time to choose reversible interventions, made with recyclable materials easily removed and discarded if no longer structurally useful. The Life Cycle Assessment (LCA) application could be a guide to make an appropriate decision about the different interventions to implement [23]. It allows determining the degree of impact of every construction process referred to a specific predetermined aspect.

While it is easy to hypothesize a wood-wood type reinforcement intervention on the timber floors of the Molino, the choice for repairing and reinforce the iron floors is not simple. With LCA method it could be possible to compare the hypotheses to restore slabs with wood (like the other floors) or iron, in addition to traditional structural analysis. This consideration would be useful in the choice of interventions aimed at contrasting first mode collapse phenomena and therefore all the safeguards necessary to guarantee box-like behavior.

A further point that should be addressed is that of post-intervention monitoring. The possibility of knowing real-time the problem occurrence, before it causes irreparable damages, is increasingly a need expecially with regard to valuable buildings. Scientific evolution in the Big Data management field, allows to expand the horizon of sensors to achieve SHMR (Structural Health and Monitoring and Reporting) systems. This makes possible to implement real early worning strategies where, due to the installation of appropriate on-site control unites, it is possible to remotely know the deformation status of significant structural elements. Even in relevant buildings such as the Molino, it would be appropriate in the opinion of the authors, to install sensors for structural monitoring. It, especially considering the possibility that the building would have a public function. Within the range of sensors available, the installation of a distributed sensor could be usefully from the structural safety point of view, because allows data detection in every point [24]. Monitoring after intervention could be an effective solution to intercept subsidence and failure before the visible symptoms appear.

5. CONCLUSIONS

In this paper, it was proposed the case study of Molino Palomba to highlight the reuse potentialities of monumental building. This ancient construction was born as an industrial structure about 200 years ago and changes his nature much time going to the needs of the times. His construction features allowed it to survive the changes without ever losing the structural efficiency even in the conditions of greater degradation. A methodological approach for restoration of the monument was proposed in the perspective of resilient thinking, providing insights to make more conscious and sustainable design choices.

An intervention that respects the nature of the original structure, and allows a new and different use is possible even in the presence of restrictive regulations and which provide for actions that were not taken into consideration at the time of construction such as seismic actions according to the current provisions.

The assessments of an economic and architectural nature have not been treated consideration the unknowing about the possible new functions that administration culd be allocated in the building.

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