Guidelines for the Restoration of ALER (Azienda Lombarda Edilizia Residenziale) Building Heritage in the Context of HBIM

Linee guida per il recupero del patrimonio edilizio ALER (Azienda Lombarda Edilizia Residenziale) alla luce dell'HBIM

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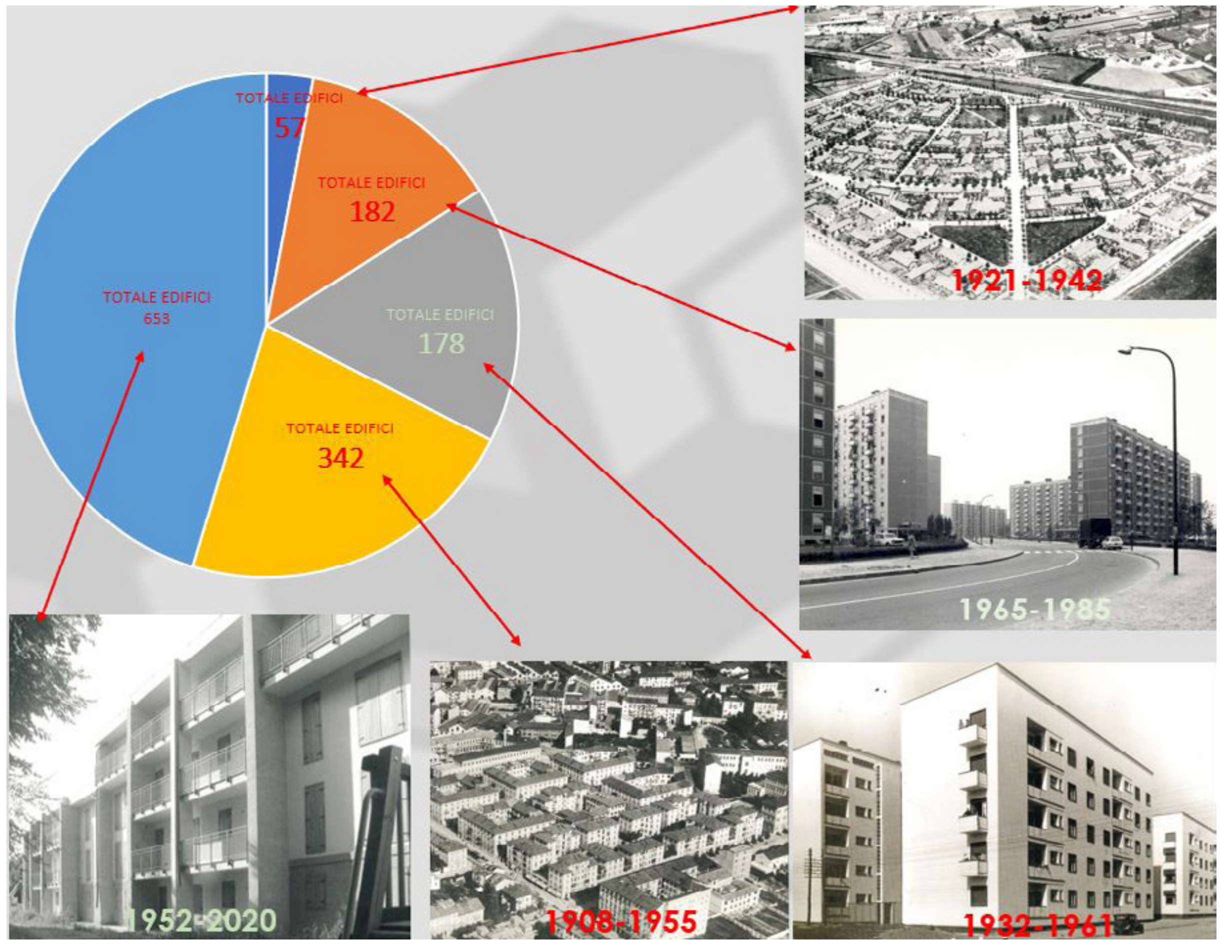
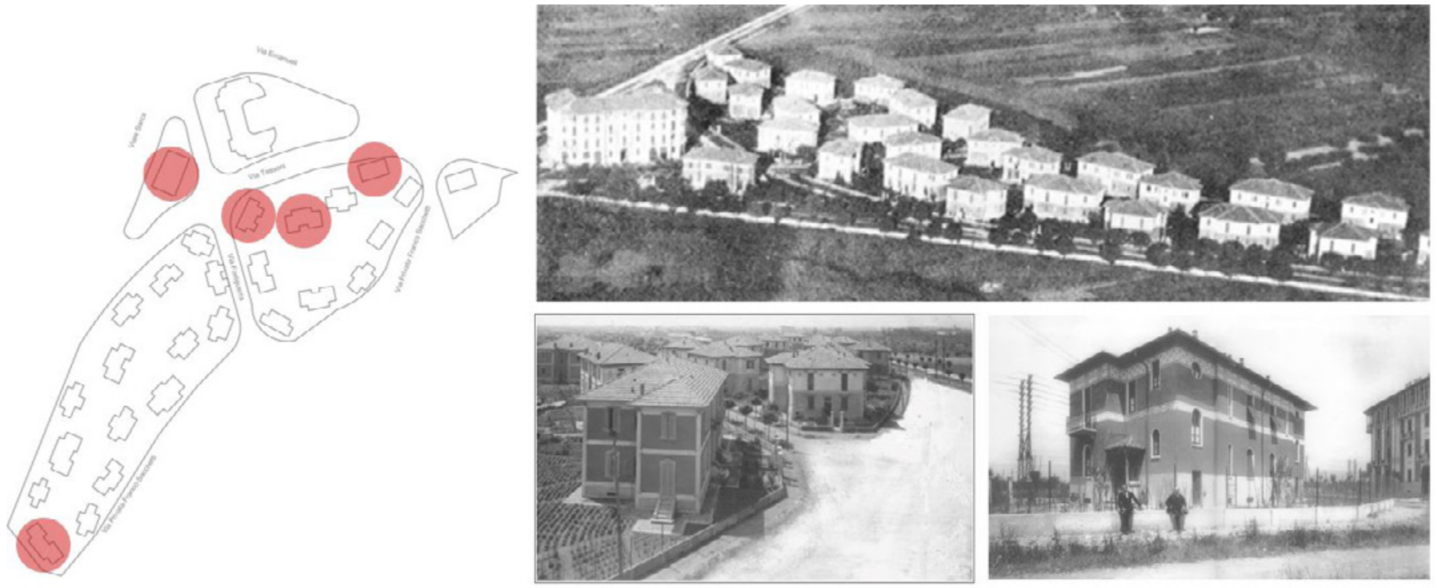
The ALER Institute (Azienda Lombarda per l'Edilizia Residenziale), founded in the early 1900s due to significant immigration driven by Milan's industrialization, has played a crucial role in addressing housing needs. ALER Milan developed a public housing stock unmatched in Europe, with approximately 70,000 owned dwellings, and an equal number alienated over time. Guided by the mission "to provide hygienic and affordable housing for the less affluent classes," ALER has significantly impacted Milan's socio-urban landscape.
To improve energy efficiency and sustainability, the Minimum Environmental Criteria for Building (CAM) were introduced in 2017. The collaboration between ALER, the Politecnico di Milano, and the Soprintendenza ai Beni Architettonici led to guidelines for interventions on historic buildings over seventy years old.
Rooted in BIM methodology, these guidelines offer a structured approach for managing or upgrading assets, considering funding opportunities and intervention urgency. They direct design and preliminary activities toward achieving clearance without replacing existing procedures. The guidelines address material degradation and thermal dispersion for historic buildings and structural vulnerability for less valuable ones proposing pre-intervention analyses and simulations based on the BIM model.
Innovation lies in shared processes between authorities and contractors, utilizing digital HBIM procedures. Case studies, like the block building on Via Lulli and the Pirelli neighborhood, demonstrate the applicability of these methodologies. The process promotes sustainable and structured management, aiming for replication in other regions and entities.

L'Istituto ALER (Azienda Lombarda per l'Edilizia Residenziale), fondato nei primi anni del 1900 per ovviare al problema dell'immigrazione significativa dovuta all'industrializzazione di Milano, ha svolto un ruolo cruciale nel soddisfare le esigenze abitative pubbliche della città. ALER Milano ha sviluppato un patrimonio edilizio pubblico senza pari in Europa, con circa 70.000 abitazioni di proprietà e un numero equivalente di alloggi alienati nel tempo. Guidato dalla missione "fornire abitazioni igieniche e accessibili per le classi meno abbienti," ALER ha avuto un impatto significativo sul paesaggio socio-urbano di Milano.
Per migliorare l'efficienza energetica e la sostenibilità, nel 2017 sono stati introdotti i Criteri Ambientali Minimi per l'Edilizia (CAM). Anche per questo motivo la collaborazione tra ALER, il Politecnico di Milano e la Soprintendenza ai Beni Architettonici ha portato alla creazione di linee guida per interventi sugli edifici storici con più di settant'anni.
Radicate nella metodologia BIM, queste linee guida offrono un approccio strutturato per la gestione o l'aggiornamento del patrimonio, considerando le opportunità di finanziamento e l'urgenza degli interventi. Esse indirizzano la progettazione e le attività preliminari verso l'ottenimento delle autorizzazioni senza sostituire le procedure esistenti. Le linee guida affrontano il degrado materiale e la dispersione termica per gli edifici storici e la vulnerabilità strutturale per quelli meno pregiati proponendo analisi e simulazioni pre intervento basate sul modello BIM.
L'innovazione risiede nei processi condivisi tra autorità e appaltatori, utilizzando procedure digitali HBIM. Casi studio, come l'edificio a blocco di Via Lulli e il quartiere Pirelli, dimostrano l'applicabilità di queste metodologie. Il processo promuove una gestione sostenibile e strutturata, con l'obiettivo di essere replicato in altre regioni ed enti.



01.
Historical typological classification of ALER buildings in the city of Milan.



02.
Analysis of the Borgo Pirelli case study with identification of the buildings surveyed and simulation.

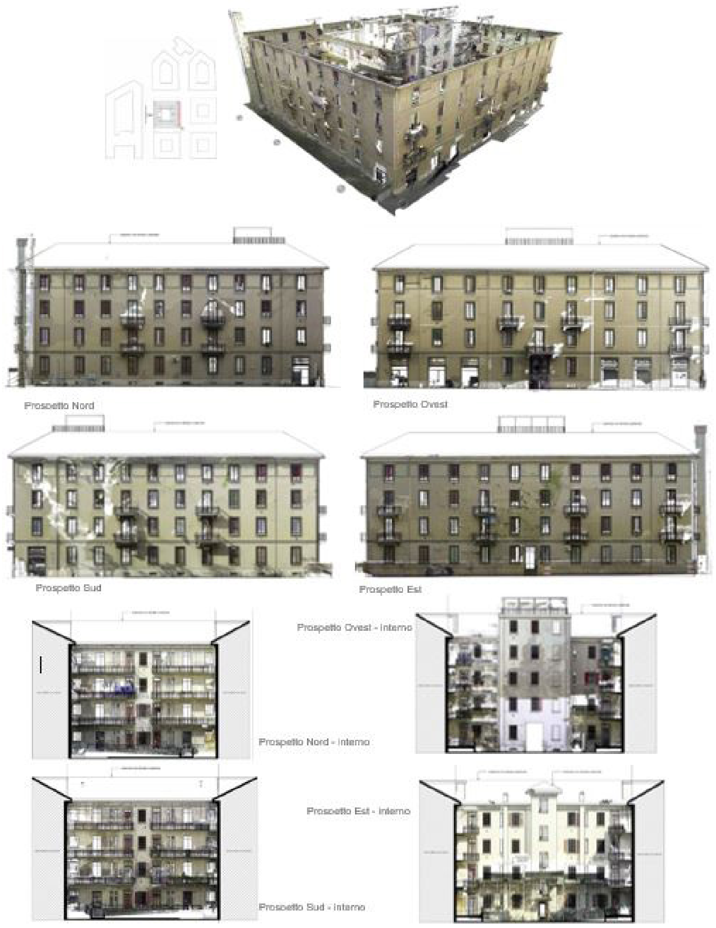
The ALER Institute (Azienda Lombarda per l'Edilizia Residenziale) was founded in the early 1900s, driven by the substantial immigration resulting from the city's industrialization. As new families moved from the countryside to Milan, there was a strong need for new housing solutions. Over several decades of construction activity since its establishment, ALER Milan has developed a public housing stock unmatched by other European companies in the sector, with approximately 70,000 owned dwellings, and an equal number alienated at various stages of the company's history, guided by the mission "to provide hygienic and affordable housing for the less affluent classes." This mission has allowed ALER to rewrite the socio-urban history of much of Milan and its hinterland, experimenting with the creation of low-income housing through public funding.
In its early years (still known as IACP Istituto Autonomo Case Popolari), ALER constructed significant buildings such as Lulli, Spaventa, Lombardia, Cialdini, and Niguarda. The initial projects were closed courtyard building blocks, arranged on four sides. The establishment of an internal technical office marked a period of high productivity; typical single-story cottage villages were built, such as the Baravalle, Campo dei Fiori, Gran Sasso, and Tiepolo neighborhoods, whose aesthetic-architectural layout was inspired by the English garden city. The intense construction activity reached its peak in the design of new residential complexes: Vittoria, Genova, Magenta, Tiepolo, Pascoli, Botticelli, Friuli, Andrea del Sarto, and Monza. The new type of social housing was characterized by internal courtyards and small gardens, with decorative elements on the facades like bow-windows, brackets, cornices, and pediments, typical of bourgeois houses of the time. The last initiative undertaken by the Institute (then still known as IACP) before the Fascist era was a partnership with Pirelli and Breda for the construction of the Borgo Pirelli village (1922) and the Borgo Breda village in Sesto San Giovanni (completed in 1926).
During the Fascist era, twenty public housing neighborhoods were built: Piola, Vanvitelli, Stadera, Solari, Villapizzone, Bibbiena, Bellinzaghi, Romagna, Forlanini, Aselli, Anzani, Mazzini, Polesine, Calvairate, Giambologna, Plinio, Lipari, and Piolti-De Bianchi, which responded to three different types: houses for redemption for the urban bourgeoisie, common social housing for heterogeneous social groups, and ultra-popular houses for the poorest classes. During the Rationalist era, experimentation fueled debate among professionals, and competitions led to the growth of neighborhoods like San Siro, Baracca, Bossi, and Filzi. The 60s/70s saw the emergence of other new types such as tower neighborhoods, with buildings between 30 and 60 meters tall.
Considering the typological variety of all buildings produced by the public agency and their significant presence within the urban context of Milan, the hypothesis of a restoration aimed at preserving their architectural peculiarities, combined with the need for energy efficiency and, in some cases, structural improvements, necessitates a coordinated design-phase action jointly undertaken by the property owner and the Superintendence. This collaborative approach constitutes the innovation of the process.

ENVIRONMENTAL CRITERIA AND ENERGY EFFICIENCY

To reduce the environmental impact of public administration's real estate sector, the Minimum Environmental Criteria for Building (CAM) were introduced in 2017, a regulatory obligation for the design and execution of works affecting the entirety of a building project. From the Minimum Environmental Criteria, rewarding criteria can be derived useful for defining scores for the application of the most economically advantageous offer (OEPV). Maintenance needs are complemented by the need for better energy efficiency and sustainability throughout the process; in this context, the innovative experimentation conducted by the collaboration between ALER and the Politecnico di Milano, supported by the Soprintendenza ai Beni Architettonici, in developped for creating guidelines for interventions on historic buildings with the intent to provide operational indications for extraordinary maintenance interventions on buildings over seventy years old.
The institution's interventions must follow a complex policy that considers both funding opportunities and the urgency of recovering some buildings over others. All operations are consistent with the evolution of the procurement code, which prominently introduces BIM methodology in the national landscape, especially in the public sector; the BIM requirement will fully enter into force for public projects over one million euros starting from 2025. The new code (D. Lgs. 36/2023) confirms the previous code's setup and D.M. 312/2021. Art. 10 of d.lgs 42/2004, combined with Article 217 of d.lgs 50/2016, set the threshold age of a public immovable property to be considered bound at 70 years, and thus subject to obtaining clearance from the Soprintendenze Archeologica, Belle Arti e Paesaggio in case of building intervention (Article 21, paragraph 4 of D.Lgs. 42/2004). At present there are several changes currently under approval by the governing bodies, including: increasing the threshold for the mandatory use of BIM from €1 million to €2 million; raising the threshold from €1 million to €5.5 million for the design and implementation of interventions for cultural heritage, with calculations based on the parametric estimate of the project's value; and the obligation to estimate the project value as indicated in the Feasibility Document of Design Alternatives. All these elements further emphasize the need for a guiding document that structures potential interventions on existing cultural heritage during the design phase.

METHODOLOGY GUIDELINES

The guidelines do not replace the procedure aimed at obtaining a building permit but direct the design and all preliminary activities to achieve a methodology for obtaining it. While the BIM methodology offers an already structured path, the varied nature of the buildings requires careful pursuit of recovery works depending on the artifact subject to intervention. For historic buildings, the recovery hypothesis confronts a detailed phase of material degradation and thermal dispersion analysis; for less valuable buildings, possibly larger, structural vulnerability will determine the dominant procedure. In these cases, the guidelines significantly contribute



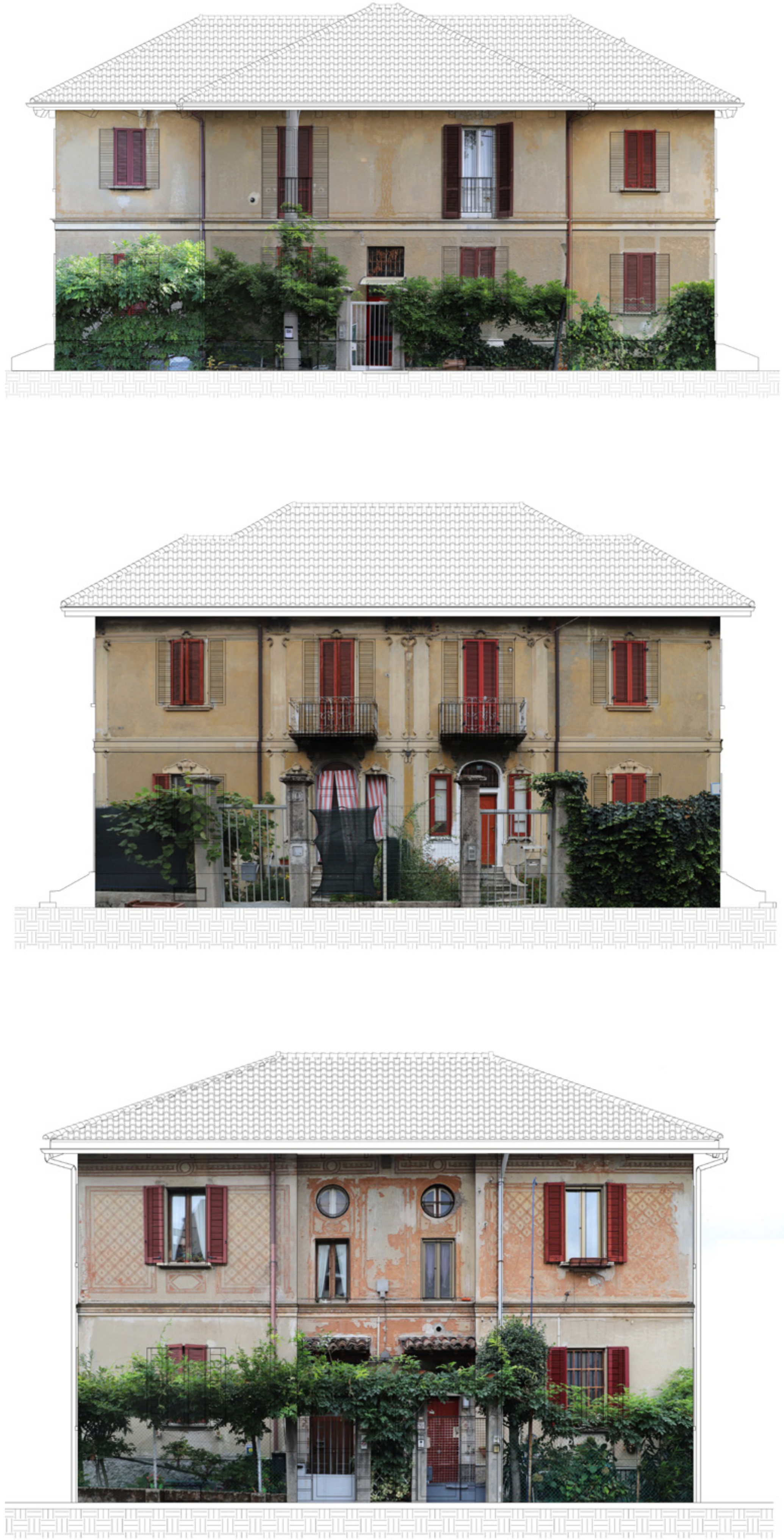
03.

Point cloud modelling of the residential block in Via Lulli.

04.

Degradation analysis and thermographic capture of a building in Borgo Pirelli.

to all operators still lacking a measured method for maintaining artifacts, guiding them towards choices already shared with the Soprintendenze. The innovation lies in the proposal: a method shared between entities under the banner of updated regulations considering HBIM. To analyze the full HBIM methodology, both in its peculiarities as a representation tool and as a predictive tool within the BIM environment, two antithetical case studies were taken as examples. The first is a previous training project conducted by the Politecnico with the company's technicians to learn how to organize a BIM model: the block building on Via Lulli. The second is a new case study: the Pirelli neighborhood , both considered protected heritage where the first is also an issue on the agenda due to public safety concerns (a large building forming part of a conspicuous settlement inhabited by socially weak groups). For both, a procedure primarily of understanding the asset was hypothesized. Lulli is one of four-story block buildings with a large inner courtyard equipped with a common garden where Broglio had already designed common spaces, "the neighborhood is the home of a large family that has its separate rooms but also its meeting places, its common studies...". The lodgings were intended for the new working class immigrating to Milan as the workforce for the new factories. This first case study was used for a Scan to BIM experiment to develop the basis for the structural and consolidation design of the building. Subsequently, an actual structural recovery project was developed by a specialised firm focusing on a consolidation hypothesis that could be developed in the building even if it is inhabited. This is a frequent condition for

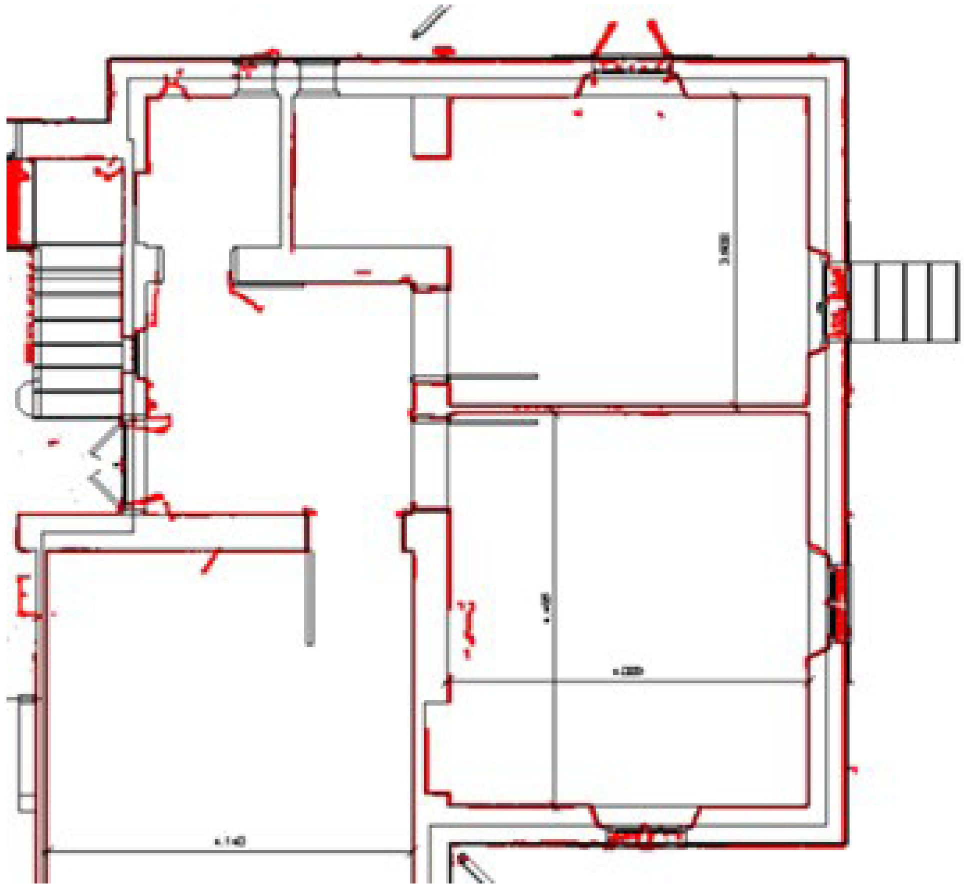


05.

Ortofoto to map one of the elevation materials in Borgo Pirelli.

06a.

06b.



06c.

06a., 06b., 06c.

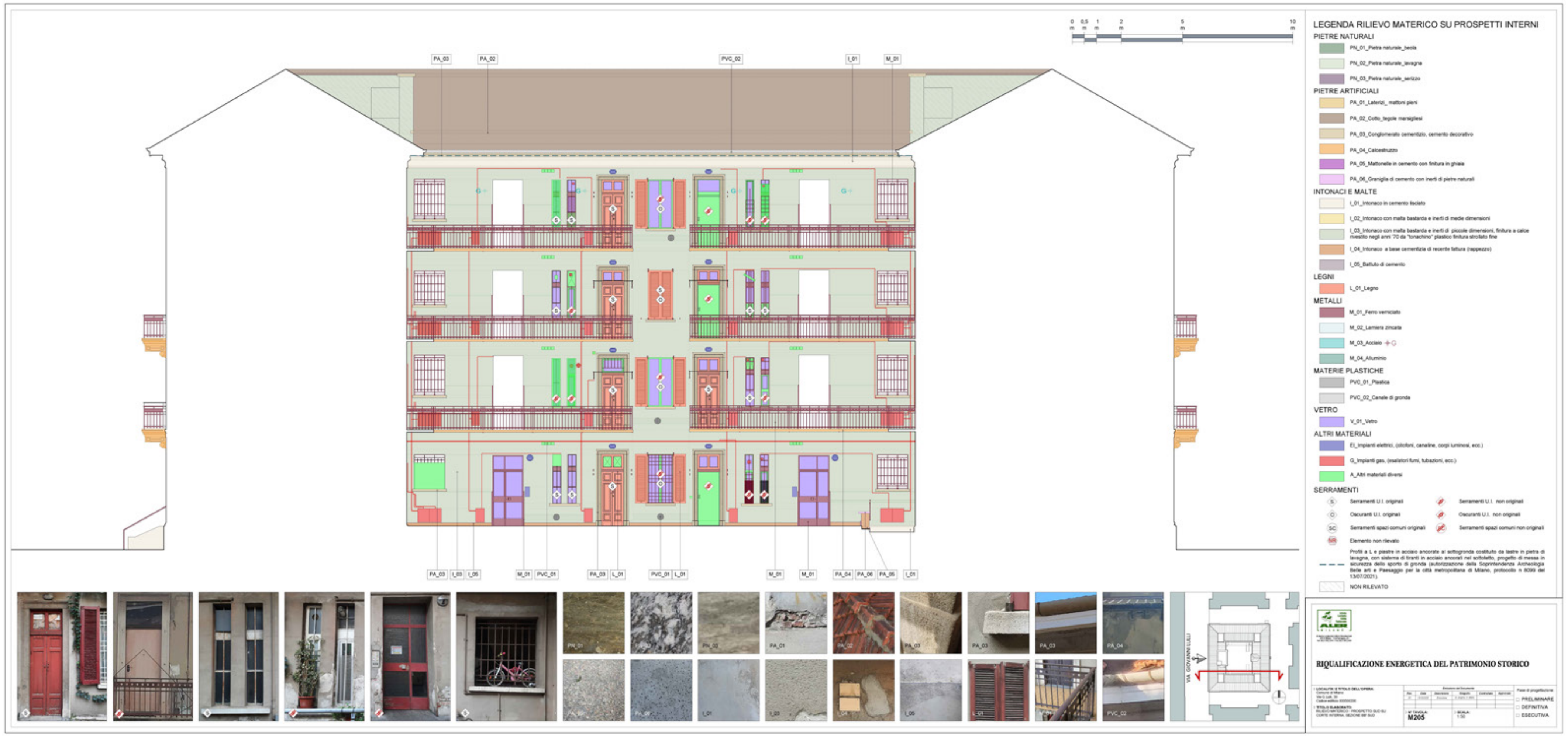
Point cloud orthophoto of the vertical connections in a building in Borgo Pirelli, point cloud modelling of section and interior of one of the flats.

the authority's buildings for which only the hypothesis of partial and temporary relocation of the inhabitants is to be considered. This condition is methodologically applicable to other similar cases. The load analyses and core drilling carried out focused on vertical connection elements, the staircase blocks present, external masonry, the floor/facade connection element easily identifiable in the stringcourses. The solutions suggested range from brackets to reconnect horizontal elements to the verticals operable from the external façade to reinforcement with reinforced mortar of vertical walls, to reinforcement with masonry elements in the basement parts. All interventions are therefore feasible while respecting the morphological and typological structure of the building.

The second case study, Borgo Pirelli is a workers' neighborhood of garden cottages, financed by the Pirelli company after World War I, as part of a series of corporate initiatives. The construction was carried out by the Istituto Case Popolari (ICP) of Milan, which also managed it. The work began in 1920 and was completed in 1923. In this case as well, an accurate digital survey was carried out using advanced tools, including a static laser scanner (RTC 360) and a dynamic survey with BLK to Go.The survey of exteriors and interiors formed the foundation for the BIM-based modelling, which was also utilized for energy efficiency simulation. The simulations were carried out within the BIM environment by experimenting with different workflows and analysis engines. Specifically, the aim was to provide tools in the guidelines to anticipate the behavior of any building modelled in the BIM environment, focusing on actual energy consumption and optimized energy needs.

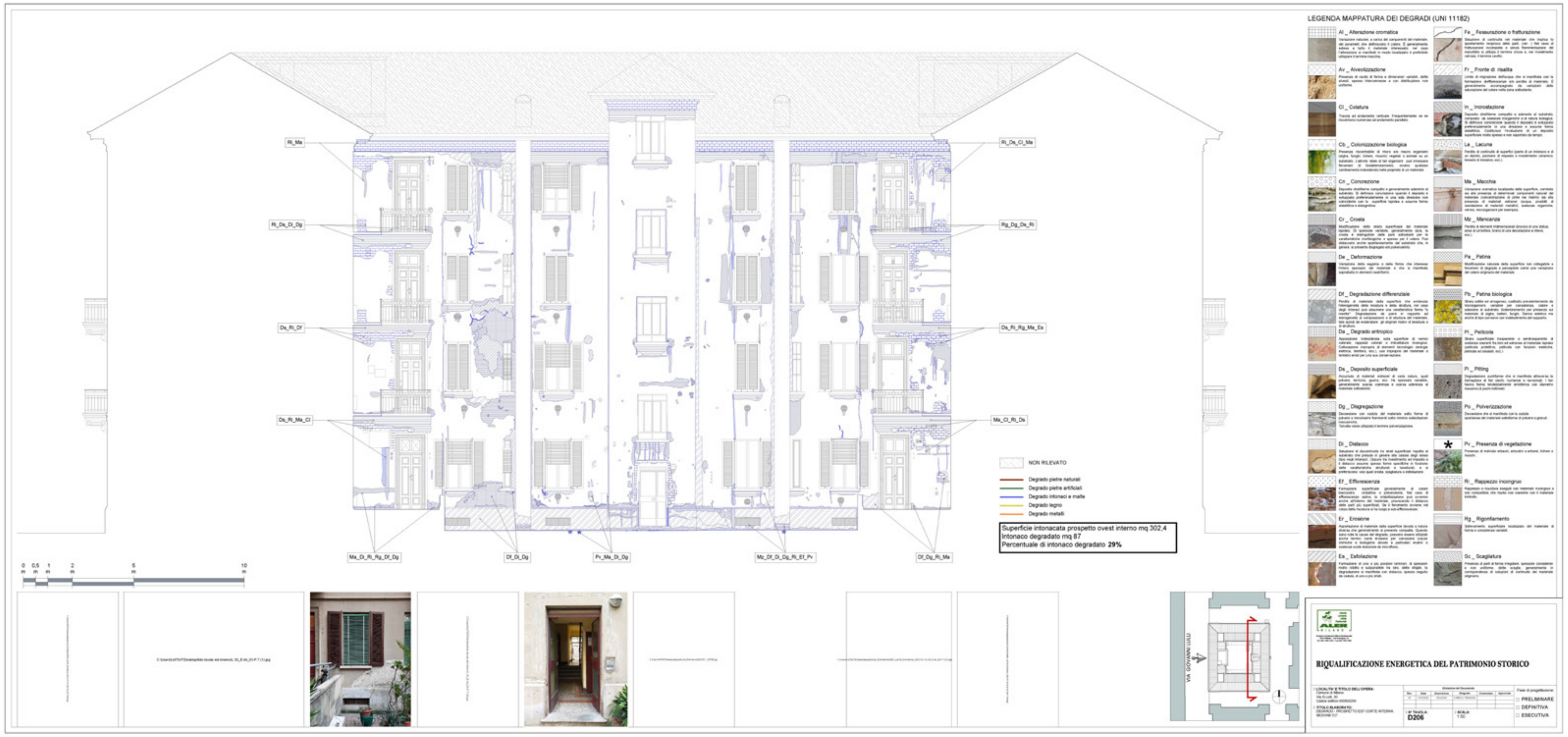
First, a BEM (Building Energy Model) was organized to initiate an energy analysis using engines capable of analyzing the digital model. An initial evaluation was conducted using Insight 360 from Green Building Studio, a plug-in for Revit, to perform a preliminary analysis of the model. Subsequently, the modeling was further refined using the Honeybee and Ladybug software, with calculations performed through Energy Plus.

As the work progressed, each structure in the energy model was adapted according to the



07.

Survey of the materials of a block in the Lulli district.



08.

Analysis of the degradation of a block in the Lulli district.

different requirements of the calculation engines, which proved to be the most labor-intensive part of the process. The thermal parameters of each individual material were exported for evaluating the EAM model. During the creation of system families, thermal parameters were directly assigned through the software. However, despite the modeling software containing preloaded material libraries, these can be modified by associating different thermal conductivity parameters.

The stratigraphies used correspond to those unaltered within the original design of the buildings, thus lacking insulation or air cavities. The BIM software can automatically calculate the thermal exchange coefficient (W/m²K) and the thermal resistance (m²K)/K for the entire package.

The workflow includes specific developments related to the structure, location, and size of spaces, which are critical for generating the energy model. This process yields the value of primary energy required for heating per unit area, expressed in kW/m²/year. This enables the planning of interventions to improve the building's energy performance in relation to stratigraphy, glazed components, or shading, applicable to any model.

METHODOLOGICAL INNOVATION

The innovation in research mainly lies in sharing processes between the contracting authority and the potential contractor and in the invitation to use not only digital procedures related to HBIM environments and models, but also but for simulative analyses with reference to both the statics of the building and the simulation of energy behaviors. At the heart of the renovation and preservation process, the guidelines establish a principle that, while not innovative, must be shared between the parties from the start: the knowledge of the asset. This knowledge is strongly encouraged not only through traditional procedures, historical analysis, visual inspection, etc., firmly based on classical survey methods but also on the concreteness of a well-structured digital and photogrammetric 3D survey and predictive modelling . The same energy diagnosis relies on different levels of survey depth that favor samplings carried out with thermal cameras to identify all connected criticalities. Designers know that methodologically they will have to face specific analysis documentation of the artifacts and provide equally detailed solutions with advanced instrumentation, placing the asset at the center. In the last chapter of the guidelines, the methodological specifics for the energy diagnosis service, geometric, architectural, degradation survey, seismic vulnerability within the projects of energy and structural requalification in a BIM environment of the assets are provided. Some themes, such as the difficulty of reproducing the real state of conservation or degradation of buildings in parametric software, the laboriousness of inserting accurate geometric surveys into the BIM model, the difficulties of reverse engineering procedures and data processing, are illustrated within the guidelines with applied examples to the two case studies here presented.

CONCLUSION

The innovation process for the energy recovery of ALER's building heritage through HBIM methodology concludes with significant results. The collaboration between ALER, the Politecnico di Milano, and the Soprintendenza ai Beni Architettonici has led to the creation of operational guidelines for interventions on historic buildings. These guidelines offer a shared and advanced method, integrating digital, photogrammetric, and thermographic surveys for precise energy diagnosis. The case studies demonstrate the applicability of HBIM methodologies, promoting the maintenance and recovery of buildings with sustainable and structured management. The hope is that this model can be replicated in more regions and entities.

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