Natural solutions for remodelling: the case study of Grupo de Viviendas Antonio Rueda

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Abstract. The objective of the research is to study innovative architectural solutions that improve the quality of life in urban environments by integrating natural elements into existing housing systems. The object of the study is requalification of the Grupo de Viviendas Antonio Rueda in Valencia with the aim of creating flexible and modular living spaces that adapt to evolving user needs while promoting a symbiotic relationship between residents and the environment. The project goes beyond sustainability and environmental quality improvement by actively engaging user-centred design methodologies to identify the preferences and needs of the inhabitants. This participatory approach ensures that the proposed solutions are not only sustainable but also socially inclusive and functional. The integration of modular and flexible design strategies allows for the evaluation of different spatial configurations and material applications, assessing their effectiveness in enhancing comfort and well-being. By utilising natural and recycled materials, the research establishes a framework for a balanced design approach that strengthens human-nature connections while improving the resilience and liveability of urban housing environments.

Keywords: Balanced design; User-Centred design; Recycled materials; Modular flexibility; Adaptability.

Introduction

In the modern society that could be described as fluid and formless, a society of the present (Lyotard, 1984), of non-places (Augé, 2009), how important is it to rediscover, understand and value the Genius Loci? Especially when we are called to provide or restore environmental quality to a city, a district, a building, today more than ever there is a need to return to a theoretical approach of balanced design (Olgyay, 1981), which considers natural resources not as surroundings, but as an integral part of the project. In the current definition, the Genius Loci refers to the spirit of a place, describing it as an integral part of the place, identifying its geometric boundaries and establishing causal connections between all the elements that compose it. Over time, places have become boundary markers and centres of life, in which it is possible to identify the matrices and relationships between the people who live there. It is also possible to detect the aspects and processes that determine the character of the place through its influence on the environment, which leads to the division of places into the functions (residential, commercial, industrial) of the people who live there (Sciortino, 2020). All the characteristic elements arising from the relationship between man and the environment can thus be defined, recognising and marking the natural or artificial limits. This relationship has in some cases led to negative effects that have reversed the man-nature nexus by activating inconsistent, destructive and unsustainable transformation processes. The processing of settlements and land has been influenced by technology and the intangible, applying solutions detached from nature and its elements. Therefore, the design and construction of one's home implies a process of elevation and interpretation of space (Marini, 2016), leaving an impression that alters the environment, irreversibly affecting its balance.

The complementary dialogue between technological innovation and architectural space invites more flexibility and adaptability, responding to a dual concept of human and environment-oriented construction (Violano, 2022). To achieve such a connection, it is necessary to model and develop elements of natural origin that lend themselves to making living space flexible and integrated through the use of nature-based solutions in order to make such environments and living centres more resilient against the adverse impact of climate change, healthier and socially cohesive. The research project investigates the possibility of optimising energy performance and water consumption (Violano and Harputlugil, 2024) by integrating natural elements into urban dwellings with a focus on the human-nature connection. The design methodology combines recycled materials, biophilic design concepts and user-centred methodologies to create adaptable living environments. The Grupo de Viviendas Antonio Rueda was used as a case study to show the practical applications of these notions.

Methodology for retrofitting

The case study of the Grupo de Viviendas Antonio Rueda, located in the city of Valencia (Spain), presents a specific interest in the theme of using materials responding to the 10R strategy for the technological and environmental upgrading of existing buildings. This is achieved through a complete analysis of the housing conditions, and by adopting a historical-critical approach that integrates qualitative and quantitative data. The methodological path reconstructs the functional and constructive evolution of the group of dwellings over time, analysing their architectural and technological features, besides their social characteristics.

Currently, places are undergoing a process of obsolescence that gives rise to considerable points of reflection on the redevelopment of the urban environment (Guajardo, 2017).

The search follows several stages:

- WP1 – Context analysis: historical and social characteristics of the residential complex, identifying morphology, building types and the current state of obsolescence of the built environment.
- WP2 – Evaluation of construction and design aspects: potential of natural and recycled materials, with particular attention to their psycho-emotional impact and sustainability.
- WP3 – User-centred design: cross analysis between resident needs and preferences. This participatory approach in design means that the proposed solutions are adaptable and user-friendly.
- WP4 – Design and prototyping: creation of modular and flexible design prototypes to study configurations and mate-

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01 | Aerial and internal view of the examined housing complex

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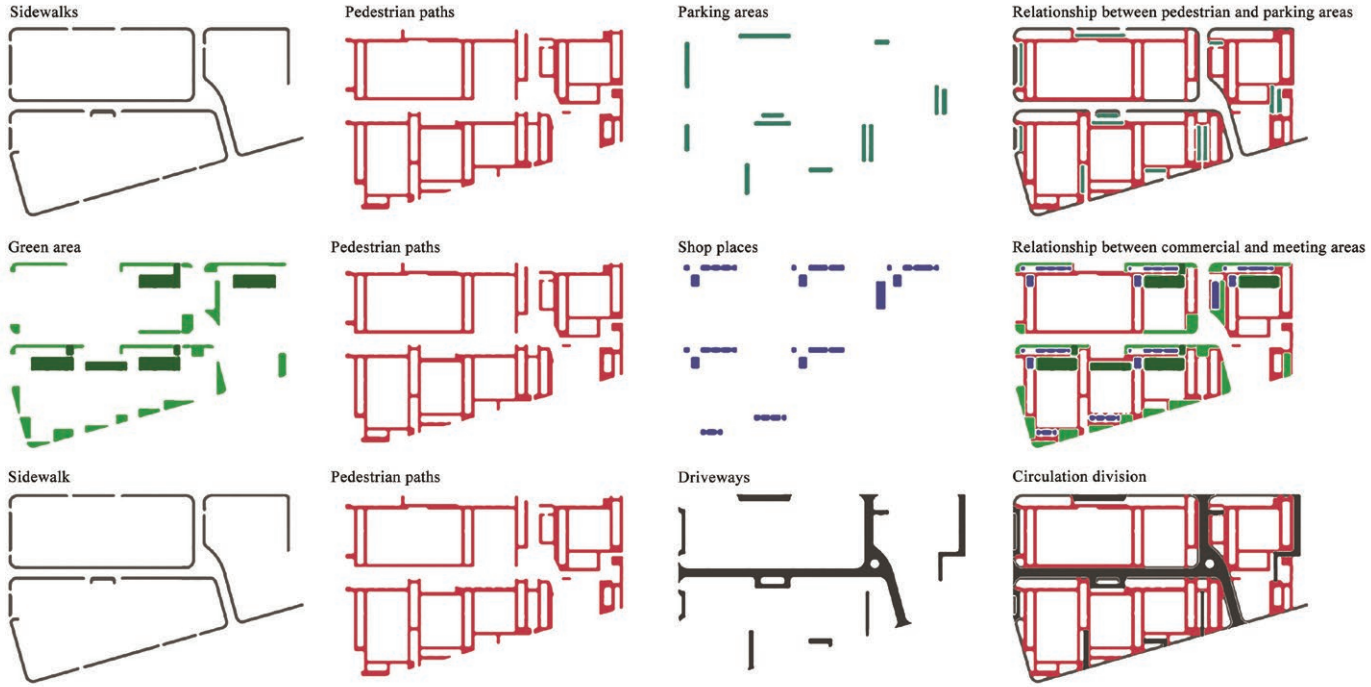
rials, allowing effectiveness in improving living conditions to be evaluated.

Phases WP3 and WP4 are the most interesting, in which research reinforces the role of participatory design, highlighting how knowledge of the needs of inhabitants contributes to the creation of more inclusive and functional spaces. Indeed, a user-centred design approach is essential to ensure that architectural solutions genuinely respond to the daily needs and aspirations of residents. Through participatory design methods, such as surveys, interviews, and focus groups, it is possible to gather qualitative and quantitative data on user preferences, habits, and challenges. This enables the development of adaptive solutions that enhance spatial functionality and comfort, fostering a stronger sense of belonging and well-being. By integrating user feedback into the design process, the project not only improves the usability and acceptability of interventions but also strengthens social cohesion and engagement within the community. The adoption of a modular and flexible design approach allows for the exploration of multiple spatial configurations and material combinations, enabling a dynamic assessment of their impact on living conditions. This adaptability not only facilitates optimisation of resources and customisation of spaces according to user needs but also enhances the resilience and sustainability of the built environment. The results demonstrate the effectiveness of the combination between natural materials, innovative design strategies and green systems, resulting in an improvement of the human-nature symbiosis. Edward O. Wilson discusses the innate human-nature empathic synergy, interpreted in the past by technological solutions based on empirical choices, but insufficient at present without the use of a control tool to verify its performance. The design approach adopted in the case study is based on the principles of circular economy, and enhances the value of local resources and waste materials. Wood obtained from the maintenance of public green areas, for example, is reused in construction, partly reducing dependence on external resources. This strategy is particularly significant in the current context, characterised by a saturated housing stock and an increasingly difficult access to new construction. The addition of autochthonous greenery in the inner courtyards contributes to strengthening biodiversity and improving the quality of life of the inhabitants, responding to the need to reconnect with the surrounding environment. The project thus serves as a model for improving the value and adaptability of existing buildings, in line with modern requirements for liveability and sustainability.

An architectural heritage: the evolution of the Grupo de Viviendas Antonio Rueda

The context analysis reveals a worrying maintenance condition of the existing social housing stock in Spain with consequent critical issues for the safety and comfort of users, who reside in housing facilities with significant criticalities. This issue is particularly important in the housing complex that is the subject of this analysis, located in the Tre Forques district of Valencia (Fig. 1). Built between 1965 and 1970, in a period of economic and social expansion, this residential complex belongs to the social housing typology. Its construction was a response to the growing demand for accommodation in the city centre, caused by the influx of population from peripheral



areas, a phenomenon amply documented by official statistics that attest to the construction of 3,347,768 buildings between 1961 and 1975. The construction of these housing estates was promoted by the policies and strategies of the Obra Sindacal del Hogar (OSH), a public organisation founded under the Franco government in collaboration with the National Institute for Housing (INV). The primary objective of these institutions was to address the housing crisis through the construction and management of social housing.

The Viviendas Bonificables Law of 1944 was an initiative of the Administration to stimulate private enterprise in the housing sector, with a focus on the construction of houses to be rented to the middle class, a segment of the population that did not have particular economic difficulties in the post-war period (Roa-Fernández, 2023). This legislation also aimed to stimulate the recovery of the building sector through the reconstruction of areas damaged or destroyed during the war, encouraging the creation of new building volumes and contributing to the re-development and regeneration of the urban context (Romano, 2024). The Grupo de Viviendas Antonio Rueda, designed by the architects Vicente Valls, Joaquín García and Luís Marés in 1965, commissioned by the Obra Sindical del Hogar of the INV, contains 1002 houses over an area of 10 hectares in a trapezoidal-shaped plot of land (DOCOMOMO, 2024).

The criteria behind the residential complex, for the architects, were the division of pedestrian and road areas; avoiding waste-land by exploiting the entire area; and encouraging relations between users through the creation of public spaces and daily-use commercial activities (Fig. 2).

Morphological analysis reveals the flexible development within the site geometry of the housing complex, showing a systemic balance between green and service areas, thus communicating a common ideal of progress and prosperity.

Each unit of the area (Fig. 3) consists of a four-storey block with a north-south orientation in the upper part, two parallel eight-storey linear blocks in an east-west direction, and single-family duplex dwellings in the middle part, which consciously take up the Cartesian Casba, according to the architects' design idea. One of the main factors taken into account when studying the distribution of the different typologies was the reduction of costs as the fundamental design criterion. Each housing unit, whose category is indicated by a letter according to its size in mq, is associated with a number denoting the floor of the unit, including the ground floor. The number following the hyphen symbol specifies the amount of bedrooms for each type of accommodation.

The total number of residences in the complex is 1002 and they are divided into:

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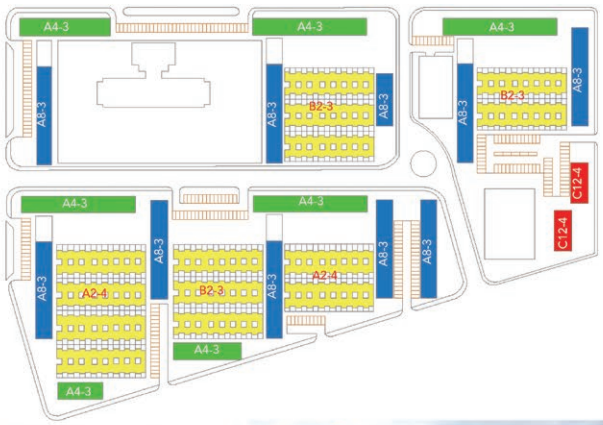


Bulding | 2 floor | Building | 4 floor | Building | 8 floor | Building | 12 floor

Category	Typology | mq	n. of housing
3rd category	A8-3 | 140 mq	560
	A4-3 | 75,97 mq	174
	A3-4 | 90 mq	96
2nd category	B2-3 | 88,80 – 76 – 90 mq	44
1st category	C12-4 | 140,14 mq	128
	total	1.002

- Type A8-3. Linear building with the largest number of apartments. Consisting of 8 floors including the ground floor, it is not a pass-through building, as it does not have cross ventilation and thus adequate internal air circulation, and it also does not have a differentiated orientation for sleeping and living areas.
- Typology A4-3. A four-storey building, of which the ground floor is used for commercial purposes. It takes advantage of the best orientation, which allows the sleeping area to face north and the living area to face south.
- Typology C12-4. These are the towers that close the project and belong to a bourgeois housing style, both in terms of the usable area of each unit and the type of location.
- Typology A2-3 and B2-3. The buildings are located in the central part of the district and consist of duplexes and single-family units. They are developed around private courtyards adjacent to the living area. The labyrinth-like union generated on the upper floor, used as the sleeping area, creates the pedestrian access paths to each unit, forming a platform that acts as a link between the various blocks. This generates an interesting play of light and shadow alternating between covered and uncovered areas.

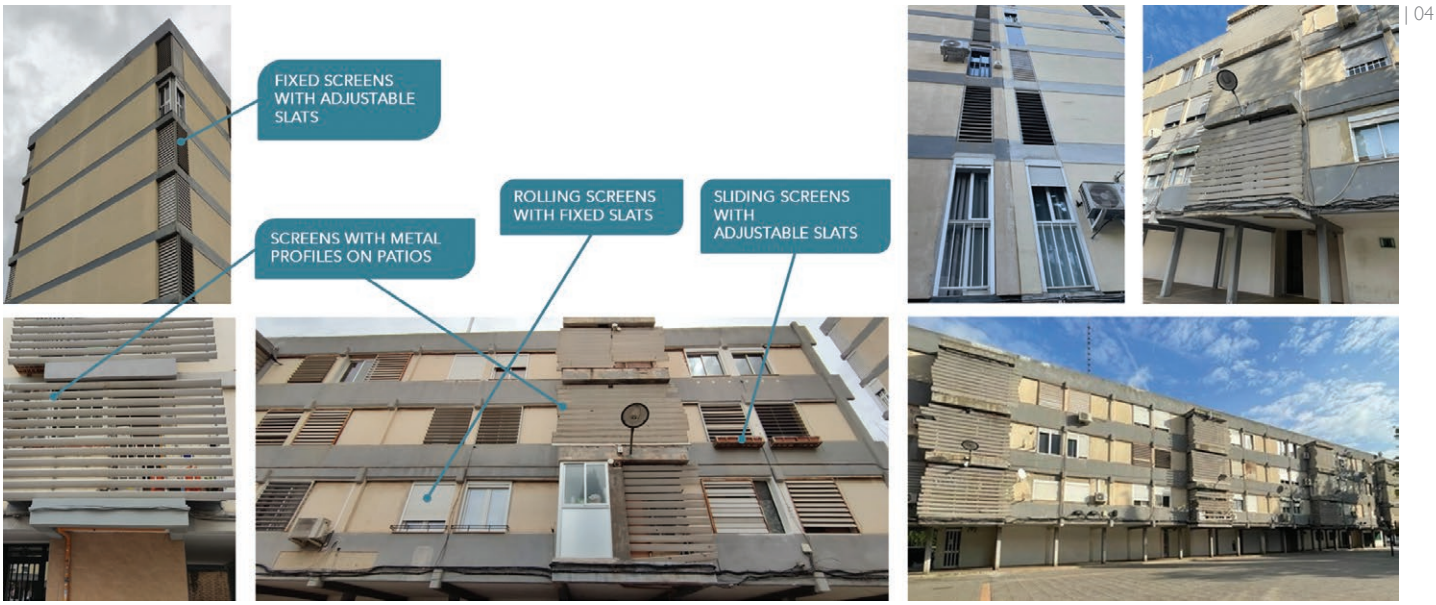
From diagnosis to regeneration: Holistic approach to sustainable retrofitting

The Grupo de Viviendas has struggled to survive the passage of time, currently finding itself in a state of obsolescence. Lack of maintenance and poor conservation have caused most of the present and visible pathologies, especially on the façades. Much of this is due to rain and runoff, which have caused staining, dampness and detachment. As far as the carpentry is concerned, poorly maintained materials have caused the lack of waterproofing and insulation, leading to their replacement by the users themselves, who have not followed uniform criteria. Incorporating new elements has exacerbated and deteriorated the aesthetics of the building, resulting in a loss of the initial design appearance (Fig. 4).

The evaluation of construction and design aspects revealed the poor construction quality of the buildings. The lack of accessibility and energy-efficient conditions due to the materials used at the time of construction and autonomous heating and cooling systems means that the vast majority of users systematically abandon these buildings in search of others with greater guarantees of comfort and well-being. At this phase, the need for a user-centred redesign was identified, considering the socio-economic context characterised by low-income families. Numerous inspections, integrated with specific interviews with the inhabitants of the residential complex, revealed widespread problems concerning the presence of mould and condensate, as well as insufficient sunlight in some housing units, which impair the wholesomeness of the environments and the occupants' well-being. In response to this evidence, the redesign favoured the use of recycled materials, optimisation of natural lighting, integration of greenery and the use of materials capable of reducing the concentration of indoor pollutants. In this perspective, the redesign is a holistic approach to sustainable building,

04 | Current condition of the buildings in the complex examined

05 | Ground floor and first floor of type B2-3, with interior and exterior views



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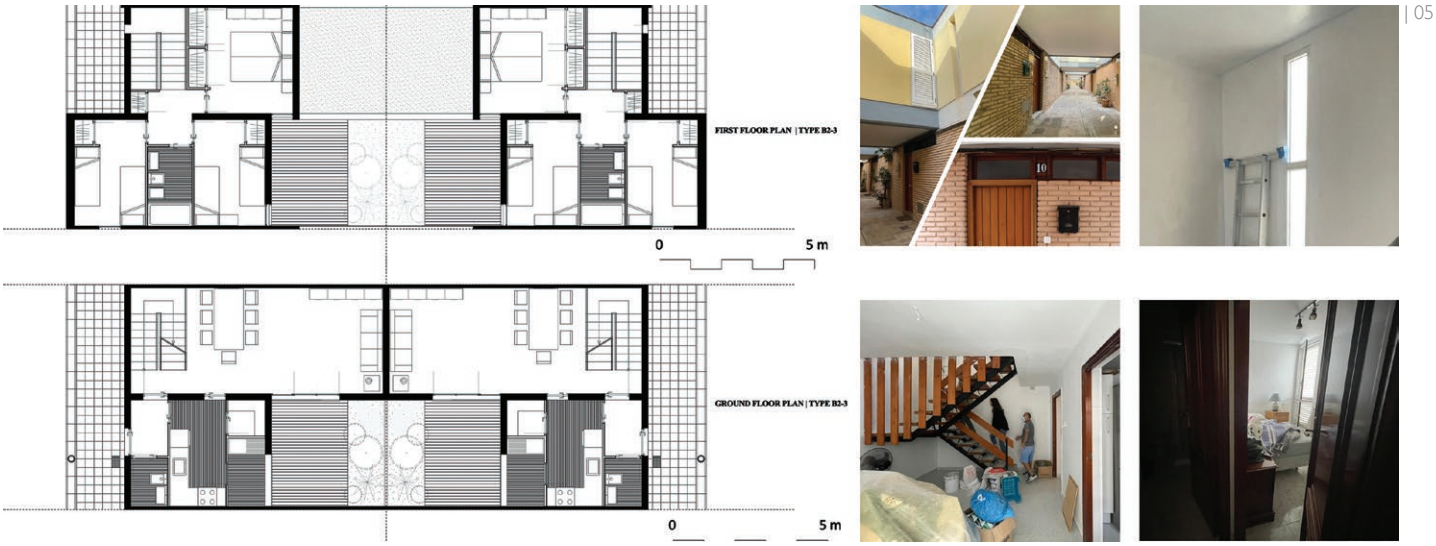

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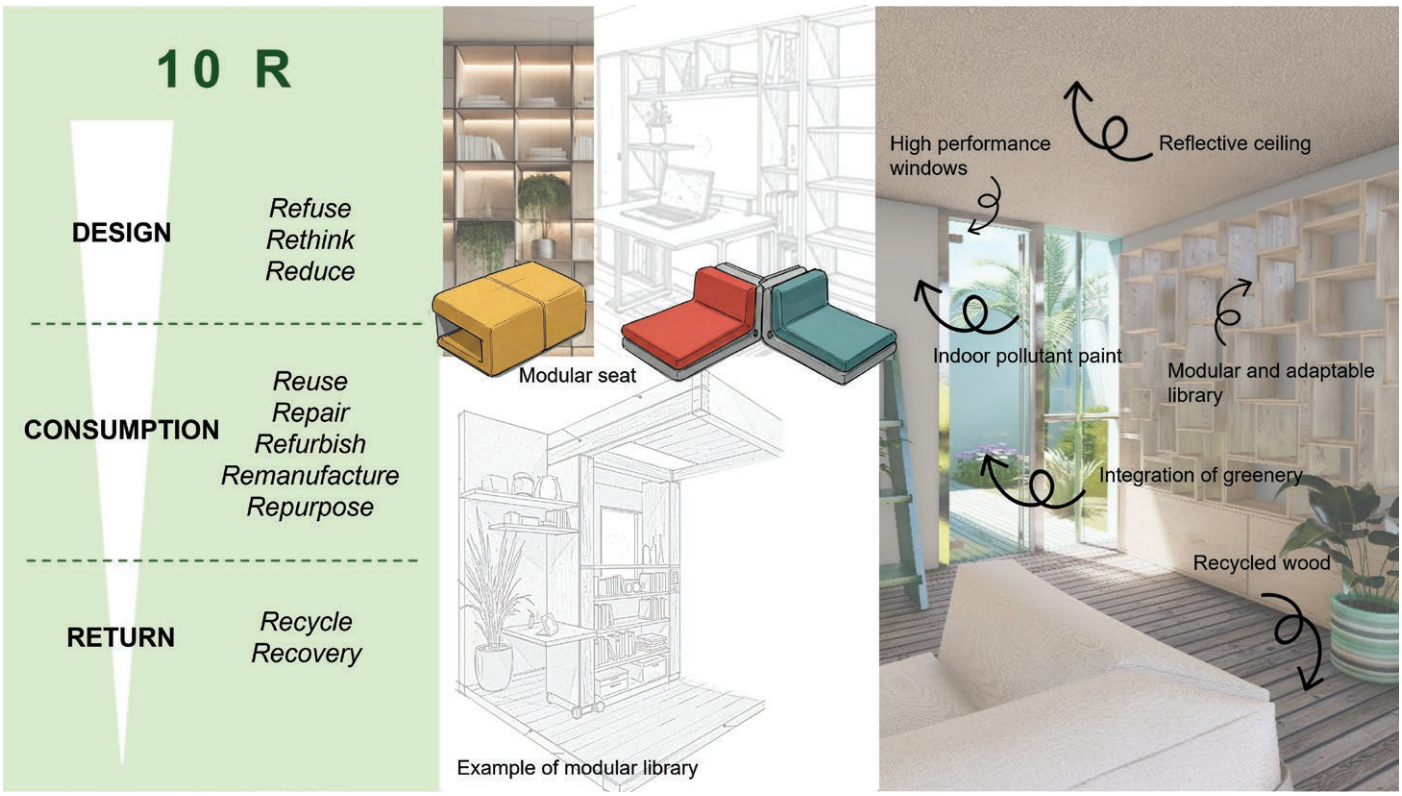
with interventions capable of combining the needs for living comfort with the principles of environmental and economic sustainability by enhancing the value of the existing building heritage and improving the inhabitants' living conditions.

Results

Designing a balanced environment that favours human-nature connections is a complex process, which requires the collaboration of different actors. The design and prototyping followed the basic principles of the 10Rs and the use of appropriate tools and strategies to create spaces that improve living comfort. An example can be found in the B2-3 building, detached and semi-detached buildings in the innermost part of the complex, with a small internal patio in common with the adjacent house (Fig. 5).

The design and construction of buildings that respond to an increasingly complex and unprecedented demand for quality of life and living require a unique approach and innovative solutions capable of establishing a creative dialogue between comfort and sustainability (Di Perna, 2022). The combination of

06 | Sketch and rendering of the interior of type B2-3



natural and/or recycled materials, the psycho-emotional use of colour, the integration of green systems to design modular, flexible and adaptable housing redevelopment are capable of triggering virtuous processes for increasing personal well-being and the human-nature symbiosis. This is also favoured by the use of recovered on site for interior spaces, e.g., wood from the maintenance of green areas for indoor flooring, the integration of vegetation into outdoor areas, such as courtyards, and the use of modular furnishings and textures in warm colours inspired by nature to create different spaces, which can be reconfigured over time to meet new needs (Fig. 6). The interconnection between modularity, flexibility, comfort and economic sustainability of the spaces reduces costs and minimises environmental impacts, ensuring their durability by helping to reduce energy consumption and running costs.

Conclusions: towards a Resilient and User-Inclusive Housing Model

The research on the requalification of the Grupo de Viviendas Antonio Rueda in Valencia highlights the profound impact that integrating natural elements and recycled materials can have on urban living conditions, particularly for low-income families. By adopting a design approach that emphasises flexibility, modularity, and sustainability, the project seeks to foster a deeper human-nature connection, which is essential for enhancing the overall well-being of community residents.

The findings suggest that employing natural materials not only revitalises the physical space but also promotes psychological comfort and emotional well-being among inhabitants. By addressing issues such as poor construction quality, insufficient natural light, and unhealthy living conditions, the redesign aims to create a holistic living environment that respects both ecological and human needs. Furthermore, this research underscores the importance of a user-centred design methodology, which actively involves residents in the planning process, ensuring that the solutions provided are genuinely responsive to their needs and preferences. The successful integration of innovative design strategies with principles of circular economy further reinforces the potential for sustainable urban housing solutions. The study serves as a model for future architectural interventions, illustrating how a balanced design that harmonises human activity with nature-based considerations can lead to healthier, more sustainable urban living environments. This approach not only preserves the Genius Loci of the area but also aligns with contemporary demands for liveability and sustainability in urban contexts.

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