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# Methodological Proposal to Resolve the Dichotomy between Improving Energy Efficiency and Preserving Heritage—Case Study: Brutalist Built Heritage

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**Abstract:** The debate about how to conduct energy interventions in built heritage remains open. At present, the various European and national regulations allow the absence of energy intervention in cases where the character of a building with recognized heritage value would be jeopardized. This situation means that heritage preservation and energy improvement are divided into two airtight and unconnected blocs. It is possible and necessary to break that dichotomy by taking steps that enable both blocs to interrelate. Based on a methodology previously proposed by the authors to regulate changes in the urban landscape due to the rehabilitation of residential building façades, as a novel aspect, this article proposes taking a further step in the methodological process. Several criteria to balance the level of energy intervention for all buildings are thus introduced, according to the urban and architectural characteristics of each building, irrespective of their use and degree of protection. It is concluded that such a balance is possible when certain indicators are used and when determined action criteria are applied. However, one of the architectural characteristics more susceptible to being affected when undertaking an energy intervention on a building's thermal enclosure is the materiality, which becomes especially important in the case of brutalist architecture with reinforced concrete, one of its most identifying features, giving it a specific personality. That architectural movement was therefore chosen for a case study, applying the proposed methodology to three brutalist buildings in the area of San Sebastián, Spain.

**Keywords:** built heritage; energy efficiency; brutalism



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## 1. Introduction

Excessive energy consumption and $CO_2$ emissions have become one of humanity's most important problems in the early 21st century. The EU has identified the construction sector as one of the key areas where steps must be urgently taken to improve this situation. The energy efficiency of buildings has been among the EU's most important goals for more than two decades, having reached the conclusion that it is necessary to renew the current building stock because it is one of the sectors with the highest energy consumption. That objective has accordingly been set out in various European directives, among them Directive 2002/91/EC [1], Directive 2010/31/EU [2], Directive 2012/27/EU [3], and Directive 2018/844/EU (amending the latter two) [4], and in the various transpositions into respective national law, such as Spain's RD 390/2021 on energy certification [5]. In any case, since it is clear that pressure to improve energy efficiency will only increase over time, a suitable balance should be sought between environmental sustainability and maintaining cultural significance [6].

The EU counts a large variety of buildings with a heterogeneous historic legacy from different periods. One question pending consideration in European legislation is how to improve energy performance in existing buildings that have recognized heritage value. Although Directive 2012/27/EU speaks of the exemplary function that buildings of public institutions should fulfill when introducing measures to improve energy performance, it also states that countries may decide not to apply those criteria in officially protected buildings when compliance with certain requisites would "unacceptably alter their character or appearance". The conflict posed by energy interventions is therefore evident. Taken to the extreme, they can jeopardize the heritage value of historic buildings; when not undertaken, they lead to excessive energy consumption and eventually to the abandonment of a certain type of architecture. In any case, it is clear that the legislation advocates preserving the "character or appearance" of protected buildings above any other consideration. But it leaves open the possibility of energy improvement using solutions that do not affect the essential architectural characteristics that give them special value, for example, by recourse to a combination of active systems and specific passive interventions.

But what happens with buildings of particular architectural value that are still not considered worthy of protection and in which any intervention may irreparably alter their "character or appearance"? The 20th century left us the youngest heritage stock in history, unknown and relatively unvalued, wherein, except for some acknowledged works by the so-called modern masters, most heritage is considered not worth preserving and is therefore particularly vulnerable. Its value or merit for being included in protection lists does not fit in the commonly used selection standards generally based on the buildings' aesthetic or visual qualities. In some cases, their importance lies mainly in their nature as a link in the chain of events that constitute the historic evolution of the history of architecture [7]. There are two criteria that reinforce each other in the reevaluation of modern architecture, differentiating it from those applied to older heritage works: the fact of being the origin of the current architecture, and the idea of sustainability, conservation, and reuse as opposed to unjustified replacement and frenetic consumption. The first one points to the current validity of its values, forms, and languages and the second to the current usefulness of such works as an essential quality that justifies their conservation and duration over time and ultimately their sustainability as opposed to simple contemplative or aesthetic enjoyment [8].

Based on the urgent need to enhance their value, here is where the major players involved (administration, architects, and conservation heritage experts) often clash due to the philosophical debates and discrepancies generated by intangible concepts such as the authenticity, significance, and value of heritage. The reasonable replacement of materials, the respect for form, the new language, or the adaptation to new functions and needs, among them being improved energy efficiency, are just some of the issues that generate controversy [9]. But we know that not all contemporary architectural heritage can be subject to equal protection and conservation. We have here a first and delicate task to define: the establishment of description and selection criteria. Flexibly and knowledgeably addressing the specific qualities of each case became increasingly common in the 20th century pathways of conservation and restoration [10]. We should protect what is a testimony of history and has recognizable architectural quality, protecting all qualified contemporary architecture, whether or not it is understood as modern in conceptual and stylistic terms. All intervention in 20th century heritage should be rationally regulated, with the establishment of clear protocols that require prior demonstration that the envisaged actions will not disfigure the specific formal and technological legacy of the work [11].

In the area of energy-improvement intervention and taking as a field of action the extensive 20th century building stock, it becomes necessary to focus on all buildings that are particularly sensitive to architectural disfigurement, in which not just their appearance but also their character are at risk. Most energy interventions have centered on the insertion of a new skin in the building's thermal enclosure, as it is a passive system that, besides improving energy efficiency, also allows the treatment and repair of eventual damage while also providing a renewed and up-to-date image. The consequences of such interventions in buildings where the design, composition, and materiality of the enclosure have significant and evident architectural value, regardless of whether or not it is officially recognized, are irreversible.

This study aims to take a further step in the intervention methodology proposed by the authors in 2023 for the rehabilitation of residential building façades [12]. That methodology, which we shall call CRIRB (Criteria for Rehabilitation Interventions in Residential Buildings), is currently being applied in a pilot experiment involving the rehabilitation of 25 residential complexes included in the Opengela program led by the Basque government in the scope of the whole Basque Country [13]. It is not, therefore, a new methodological proposal but rather a progressive advance in the CRIRB methodology, a new version that we shall call CRIRB+ to differentiate it from the previous version. It has three major new features: expansion of the scope of application to all contemporary buildings, irrespective of their use and degree of protection; the inclusion of specific new construction elements such as the recesses or the roof; and the introduction of several energy intervention criteria, the aim being to establish a balance between possible energy intervention strategies and preservation of the buildings' architectural values.

The main contribution of the proposed methodology is to endow administrators with an easy-to-apply tool enabling them to regulate aspects concerning the architectural and urban image when a rehabilitation is planned, seeking a balance between the necessary energy improvement and preservation of the built heritage.

It is a much-needed methodology for typologies in which the respective skins' materiality constitutes the maximum expression of their singular nature and whose alteration could lead to catastrophic disfigurement in heritage terms. A clear example of this includes the brutalist buildings with reinforced concrete enclosures, which, in the third chapter of this text, will serve as a case study for the proposed methodology.

## 2. Materials and Methods

### *2.1. The Theory for Energy Intervention in Built Heritage (TEIBH)*

Very few energy interventions being carried out nowadays take into account how those actions affect the architectural and construction characteristics of the original building or the respective urban landscape. The energy-improvement results prevail over any other consideration. Conversely, the energy-improvement option for some buildings is ruled out due to the simple fact of belonging to the group of buildings that do not have to achieve that improvement because they are included on a protection list. It is therefore necessary and urgent to seek solutions to break the existing dichotomy between protection of the building stock and energy intervention so that, in a short time, we do not have to face the paradox of having some cities that are reasonably efficient from the energy standpoint but are hard to recognize. Figure 1 shows the division resulting from current legislation on energy intervention in built heritage. The conservation level and the energy efficiency level are divided and separated into two airtight blocs without any interrelation at all, allowing, on the one hand, non-intervention in protected buildings when the character or appearance are considered to be at risk and, on the other, full intervention without any type of limit if no protection is in place.

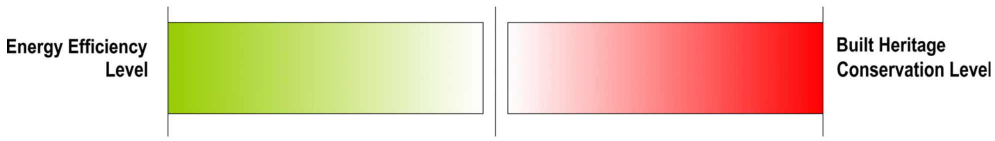



**Figure 1.** Conceptual diagram of the current regulatory consideration of energy efficiency and conservation of built heritage, divided and separated into two airtight blocs.

The solution involves defining an equation in which energy intervention in the building stock and respect for the buildings' architectural configuration are introduced as variables, the aim being to achieve a reasoned balance between the two. This concept constitutes the basis of what we shall hereinafter call the TEIBH (Theory for Energy Intervention in Built Heritage) [14]. When the intervention affects construction elements that may alter its architectural configuration and by extension the urban landscape, it will be necessary to weight the energy intervention. In some cases, the energy objectives may reach the maximums; in others, they will be halfway; and in some extreme cases, they may be practically nil because any kind of intervention will be limited. Conversely, and in the same proportion, it will be possible to preserve certain characteristics of the building, depending on its heritage value. To achieve this goal, the first step shall consist of determining the building's protection degree in order to next establish the action criteria, among which the permitted energy intervention level will be included.

The TEIBH establishes four energy intervention levels (EILs) when intervening in elements that may be protected in a building and whose concealment or alteration would be a major loss from the heritage standpoint. Interventions in parts or areas with no architectural value, such as the interior sides of previously lined floors, walls, and ceilings, will always be allowed and fall outside the established classification. The following are the proposed EIL levels:

Level 1: Invasive intervention. The aim is to obtain the greatest energy improvement. The passive measures may completely cover the original enclosure.

Level 2: Major intervention. Although the energy-improvement objectives prevail, and the intervention may eventually affect the whole enclosure, consideration should be given to preserving certain architectural characteristics of the building.

Level 3: Selective intervention. The building has significant heritage values that prevail over the energy intervention, which should be selective after exhaustive prior analysis.

Level 4: Conservation, restoration, and reconstruction. This constitutes zero or minimal energy intervention, the aim being to preserve the high heritage values of the original building.

The intervention levels are progressive and inversely proportional to the protection degree achieved by the building. The relationship between both is graphically explained by means of a diagonal line that breaks the existing division between the two airtight blocs, interrelating them (Figure 2).

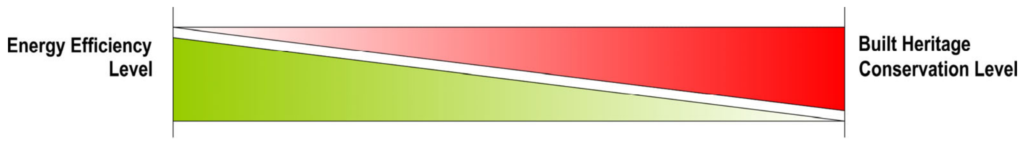



**Figure 2.** Conceptual diagram of the Theory for Energy Intervention in Built Heritage (TEIBH), in which both concepts are interrelated.

Although it forms part of a building group and shares certain compositional or construction features, each building is unique. No construction is the same as another one for various reasons, such as the historic time when it was built; the urban surroundings; the intended use; the designer; the compositional, volumetric, and formal characteristics; the construction typology; the materials used; the energy efficiency degree; the level of usage; deterioration; the degree of alteration; or the maintenance received. All these characteristics determine the singular nature of each building, defining the character to which Directive 2012/27/EU alludes. The term character, understood to mean the set of qualities of a building that distinguishes it from all others, is not expressly defined in that directive and is therefore open to multiple interpretations. On many occasions, the only qualities taken into account when specifying the term's meaning refer to the building's image or aesthetics. We believe that heritage listing should have a broader focus and consider the set of characteristics indicated above, understanding the character of a building as its personality or soul.

The current architectural worth of a building will therefore depend on multiple factors that should be analyzed and correctly valued by technical personnel from the corresponding administration when establishing a determined protection degree. Accordingly, the linear progression reflected in the conceptual TEIBH diagram should be broken, adjusted, and adapted in each case to the specific architectural qualities of the building and the type of intervention foreseen.

In sum, this means endowing authorities with a tool that allows them to regulate energy interventions according to the heritage values of a building [15]. The proposed methodology should ultimately be set out in a municipal rehabilitation catalogue indicating appropriate actions for each and every building and architectural complex in the municipality.

### *2.2. Design of the Methodology*

Practical application of the TEIBH requires encompassing all the building typologies found in any municipality. Based on the CRIRB methodology proposed in 2023, during the first phase the building's vulnerability [16], in the event of a rehabilitation, intervention will be determined. For this study, that vulnerability is defined as the potential risk that certain architectural characteristics of a building unit may be affected. This shall be called the building vulnerability degree (BVD), specified by a numerical value between 0 and 100. The indicators to be taken into account when calculating it will be compositional value, materiality, construction quality, alteration degree, construction deterioration, energy qualification, recognized quality, and accessibility degree. In the case of residential buildings, and only in their case, the complex vulnerability degree (CVD) should also be defined, likewise on a scale from 0 to 100; it determines the vulnerability of the residential neighborhood or complex where the building is located. To calculate the CVD, the indicators to apply are the unitary nature, typological homogeneity, chromatic homogeneity, alteration degree, recognized quality, and urban relevance. The exclusion of CVD calculation for non-residential buildings with any other use is because, except in specific cases, they are buildings with their own architectural singularity, spread out in location and not usually grouped under homogeneous typologies. In any case, if this is not so, and they do constitute a recognizable building complex, then their CVD should be determined.

In the second phase, the protection degree to assign to each building shall be determined, obtaining a value called the rehabilitation protection degree (RPD), graded between I and V, which refers to the varying need for a building to preserve its previous characteristics. For residential buildings, that value is obtained by combining the CVD and BVD values, while, barring the aforementioned exceptions, in other buildings, it solely depends on the BVD value.

Once the characterization of each building is completed with the CVD, BVD, and RPD values, in the third phase, the various intervention possibilities are studied, also including the principles established in the TEIBH concerning energy efficiency improvement measures. The buildings and housing complexes already protected and included in the various heritage protection plans or lists are purposely excluded from that analysis so as to not interfere with already envisaged intervention criteria. However, when reworking the methodology to incorporate the TEIBH criteria on energy intervention, it is advisable to include them to assure more in-depth resolution of the conflict between preservation and energy improvement. In cases where the architectural characteristics to safeguard were already previously defined by the corresponding competent authority, the RPD shall be obtained by means of a proportionate and reasoned transfer of the official values. If there is any discrepancy, lack of specificity, or obvious disparity in the criteria used, the building's RPD value could be obtained by using the proposed methodology and comparing both results.

Ultimately, what is proposed is to take a further step in the CRIRB methodology, which initially addressed how to intervene in the façades of residential buildings, highlighting, among others, the inclusion of the following two aspects: on the one hand, broadening the scope of application to all buildings in the municipality, irrespective of their protection degree and use, and, on the other, the extension of the intervention criteria for energy efficiency improvement to the building as a whole, as stipulated in the TEIBH. Figure 3 summarizes the different phases of the proposed methodology:

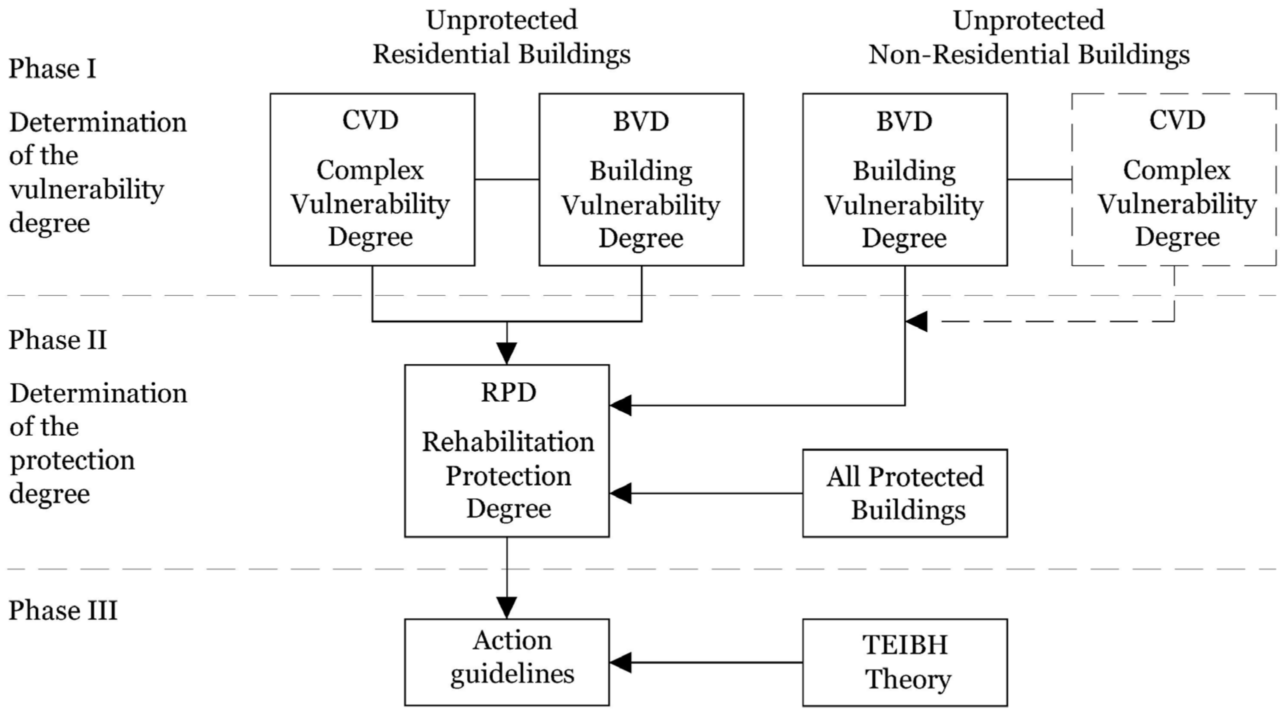



**Figure 3.** Organization of the CRIRB+ research method.

The CRIRB methodology defines how to obtain the CVD, BVD, and RPD values in the municipality's residential buildings. After critical and detailed analysis of the indicators proposed for calculating the CVD and BVD, it was concluded that they continue to be perfectly valid for characterizing and determining the vulnerability of the entire building stock of a municipality. Hence, it was not deemed necessary to modify their characteristics, maintaining the number of indicators, their definition, the weighting percentages, and the grading criteria and values. Table 1 summarizes, as a reminder, how to obtain the CVD and BVD values. The detailed evaluation criteria can be consulted in the full tables conveyed in the CRIRB methodology described in the cited article referenced within [12].

In the case of the RPD, the way to obtain the five protection degrees (I, II, III, IV, and V) varies depending on the type of building. In the case of unprotected residential buildings, the assigned value is still obtained by combining the CVD and the BVD of the building proposed in the CRIRB methodology. In the case of unprotected non-residential buildings, unless they form part of a recognizable complex, the RPD is directly and proportionally linked to the BVD value obtained. If they form part of a complex, its respective CVD will have been calculated beforehand, and the CVD and BVD combination proposed for unprotected residential buildings should be used. And finally, in the case of protected buildings of any type, it is necessary to establish a correlation between the officially recognized protection degrees, different in number and name depending on the body in charge of drawing up the list in each municipality, and the five degrees envisaged in the proposed methodology. Table 2 summarizes how to obtain the RPD values in each case.

**Table 1.** Determination of the CVD and BVD.

| **Determination of CVD (Residential Complex Only)** | | | |
|---|---|---|---|
| **Indicator** | **Weight (%)** | **Grade** | **Value** |
| Unitary project (UP) | 20% | Yes | 20 |
| | | No | 0 |
| Typological homogeneity (TH) | 20% | 1–100% of bldgs. | 20 |
| | | 61–80% | 15 |
| | | 41–60% | 10 |
| | | 11–40% | 5 |
| | | 0–10% | 0 |
| Chromatic homogeneity (CH) | 20% | 1–100% of bldgs. | 20 |
| | | 61–80% | 15 |
| | | 41–60% | 10 |
| | | 11–40% | 5 |
| | | 0–10% | 0 |
| Alteration degree (AD) | 20% | 0–10% of bldgs. | 20 |
| | | 11–40% | 15 |
| | | 40–60% | 10 |
| | | 61–80% | 5 |
| | | 81–100% | 0 |
| Recognized quality (RQ) | 8% | Exceptional | 8 |
| | | High | 5 |
| | | Medium | 3 |
| | | Low or none | 0 |
| Authorship relevance (AR) | 8% | Exceptional | 8 |
| | | High | 5 |
| | | Medium | 3 |
| | | Low or none | 0 |
| Location of the complex (CL) | 2% | Historic centre | 2 |
| | | Expansion (*ensanche*) districts | 1 |
| | | Outskirts | 0 |
| Numbers of buildings (BN) | 2% | >20 | 2 |
| | | 4 ≤ X ≤ 20 | 1 |
| | | <4 | 0 |

| **Determination of BVD (all Types of Buildings)** | | | |
|---|---|---|---|
| **Indicator** | **Weight (%)** | **Grade** | **Value** |
| Richness of composition and materials (CR) | 20% | Very high | 20 |
| | | High | 15 |
| | | Medium | 10 |
| | | Low | 5 |
| | | Very low or none | 0 |
| Construction quality (CQ) | 15% | Very low or none | 15 |
| | | Low | 11 |
| | | Medium | 7 |
| | | High | 3 |
| | | Very high | 0 |
| Alteration degree (AD) | 15% | Very low or none | 15 |
| | | Low | 11 |
| | | Medium | 7 |
| | | High | 3 |
| | | Very high | 0 |
| Construction deterioration (CD) | 15% | Very high | 15 |
| | | High | 11 |
| | | Medium | 7 |
| | | Low | 3 |
| | | Very low or none | 0 |
| Energy qualification (EQ) | 15% | G | 15 |
| | | F | 11 |
| | | E | 7 |
| | | D | 3 |
| | | ≥C | 0 |
| Recognized quality (RQ) | 8% | Exceptional | 8 |
| | | High | 5 |
| | | Medium | 3 |
| | | Low or none | 0 |
| Authorship relevance (AR) | 8% | Exceptional | 8 |
| | | High | 5 |
| | | Medium | 3 |
| | | Low or none | 0 |
| Need to improve accessibility (AI) | 4% | Yes | 4 |
| | | No | 0 |

Once the RPD value is assigned to each building, it only remains to establish the criteria for intervention in the building's different construction elements, including various energy-improvement guidelines according to the principles set out in the TEIBH. The strategies that can be put forward when the time comes to improve a building's energy efficiency are divided into two large groups: passive ones and active ones. In the case of new construction, a good urban and architectural approach implicitly contains several passive measures which, as in the Passivhaus standard, may eventually dispense with any active system [17]. The same does not occur when intervening in existing buildings for which the location, arrangement, orientation, and architectural and construction configuration are already given. In such cases, the passive measures center almost exclusively on improving the building's thermal enclosure, which should not be limited solely to the simple attachment of new insulating skins but can rather include new architectural volumes to make them more efficient from the standpoint of energy, architecture, and urbanism, as in the case of the intervention carried out by Lacaton and Vassal in the Grand Parc neighborhood of Bordeaux in 2017 [18]. Interventions to improve the thermal enclosure have experienced a tremendous boom in recent years due to the deficits presented by an aged and obsolete buildings stock and the strong requirements imposed by different administrations in the European national or regional scope. They also count the advantage that integral actions in a building's enclosure in turn enable repair of the more than likely pathologies generated over the years, and on the other hand, no less important is the improvement of the construction quality of the exterior cladding, updating and modernizing its appearance. And this is precisely where a problem may arise: the original architectural disfiguration that may irreparably affect the building's character, as referenced in the European legislation.

**Table 2.** Determination of the RPD (rehabilitation protection degree).

| | | | | | | |
|---|---|---|---|---|---|---|
| **Unprotected Residential Buildings (and Unprotected Non-Residential Buildings Included in a Complex)** | | | | | | |
| **RPD** | | **BVD Building Vulnerability Degree** | | | | |
| | | **0–20** | **21–40** | **41–60** | **61–80** | **81–100** |
| CVD Complex Vulnerability Degree | 0–20 | I | II | III | IV | V |
| | 21–40 | II | II | III | IV | V |
| | 41–60 | III | III | III | IV | V |
| | 61–80 | IV | IV | IV | IV | V |
| | 81–100 | V | V | V | V | V |
| Unprotected Non-Residential Buildings (not included in a complex) | | | | | | |
| | | BVD Building Vulnerability Degree | | | | |
| | | 0–20 | 21–40 | 41–60 | 61–80 | 81–100 |
| **RPD** | | I | II | III | IV | V |
| All protected Buildings | | | | | | |
| **RPD** | | Correlation with official values | | | | |

Hence, when it is time to put forward the different intervention possibilities, it is important to distinguish the different parts of the enclosure to see how each of them will affect the configuration of the aforesaid character and in what percentage and how to eventually intervene in the whole. Obviously, as indicated in the CRIRB methodology, the definition, valuation, and application of the different action options generically set forth will also depend on the criteria of the municipal officials in charge of regulation and even of the construction solutions that can be provided by the market at any given time. It must therefore be a rigorous though flexible tool that helps lawmakers establish intervention guidelines in each case, with the ultimate goal of avoiding the architectural disfiguration of both the building and the urban environment. The action criteria adopted are shown in Table 3.

The need for flexibility when interpreting the proposed action criteria must be stressed. Each building is unique, and cases will inevitably arise in which the intervention approach does not fully fit the criteria set out in the table, and it becomes necessary to study it in depth to identify the highest of its values that can be preserved and enhanced as well as the shortcomings and problems to eliminate [19]. On the other hand, it may happen that, regardless of the BVD and RPD values reached for the building, some specific characteristic of a certain construction element, such as its materiality, should be protected above any other consideration.

**Table 3.** Action criteria.

| Action Criteria | | RPD Rehabilitation Protection Degree | | | | |
|---|---|---|---|---|---|---|
| | | **I** | **II** | **III** | **IV** | **V** |
| Façade | Composition and volumes | Free modifications | | Occasional modifications after prior analysis | | Maintenance or recovery of the original solution |
| | Color | Free modifications | Possible modification, subject to analysis by municipal technical personnel | | Recovery of the original color in all elements | |
| | Materiality of blind wall cladding | Free modifications | Possible modification, subject to analysis by municipal technical personnel | | Similar to the original. Concrete, facing brick or stone: prior analysis | Mandatory recovery of the original finish |
| | Windows and other gaps | Free modifications | | Replacement of carpentry and glass after prior analysis | | Maintenance or recovery of the original solution |
| | Closure of balconies over time | Maintained, unless otherwise required by regulations | | Elimination recommended and possibility of new unitary design | | Mandatory elimination |
| | Fixtures per façade | Maintained, unless otherwise required by regulations | Concealment recommended | | Mandatory concealment | |
| | Barriers, railings and parapets | Possibility of unlimited replacement | Changes of design and homogenous material permitted on the entire façade | Material similar to the original, with possible change of homogenous design | Recovery of the original solution, maintaining the design though allowing change of material in the case of metal railings | |
| Roof | Composition and volumes | Free modifications | | Occasional modifications after prior analysis | | |
| | Materiality | Free replacement of finishes | | | Replacement of finishes after prior analysis | |
| Energy efficiency improvement intervention (elements to be protected) | Energy Intervention Level (EIL) | 1 | 2 | 3 | | 4 |
| | Area of intervention | Façade + gaps + roof after prior analysis | | Gaps + roof after prior analysis | | None |
| | | Active strategies | | | | |
| Additional conditions | | | | | | |
| Buildings in complexes with homogeneous original features | | No limit | Similar chromatic solution | Similar construction and chromatic solution | Same construction, chromatic and accessibility solution | |
| | | A different, unitary and homogenous transformation solution is permitted for the entire complex to optimize energy efficiency, subject to analysis by municipal technical personnel | | | | |
| Identical buildings sharing a single block or built volume | | Same color and same construction and accessibility solution | | | | |

*2.3. The Question of Materiality*

The expression of the different architectural elements is manifested differently according to their materiality [20], influencing sensorial perception that, via sight, touch, smell or hearing, we can receive when we dwell in each space. The materiality of architecture, constantly being reformulated over the course of history, has undergone a gradual dematerialization of its tectonic component [21]. That dematerialization became one of the fundamental principles of 20th century architecture, when the building's enclosure was definitively disconnected from its structural mission.

The loss of material is obvious in the gradual thinning of the structural elements or the enlargement of glass surfaces. There is another physical characteristic less discernable than the ones cited, whose perception has been changed with technological development. That elemental quality is none other than time. Architecture, historically conceived to last, has accepted its ephemeral condition. Ingenuity and the development of materials have served to produce increasingly ethereal architectures, and technological development has only underpinned that fact. With the turn of the century and the emergence of bits on the scene, the most daring have even begun to question the actual need for physical construction [22]. Now freed from any material ties, turn-of-century architecture has exploited abstraction to create impressive scenographies. The building's structure is not conceived as an organizing element but rather as a support for a more or less light skin, in which the materials take on unexpected functions. Modernity is inherent to boldness, and this architecture represents the exploration of all the possibilities offered by technology. It would seem that architectural design as an artistic discipline is seeking to detach itself entirely from the senses inherent to its physical condition.

Despite this, architectures in which the tectonic component of their materiality is one of their most important features continue to exist. Architectures with enclosures lined with strong skins of stone, concrete, or brick are therefore perfectly identifiable, and these along with other characteristics confer upon them their personality or character. It is therefore appropriate to call for a space to reflect about materiality not just because it represents one of the few certainties that remain to us but also because it is part of the memory that constitutes the cultural value of architecture. And that materiality is precisely the most sensitive and vulnerable architectural quality in an energy intervention, where the superimposition of a new skin may irreversibly annul its original character. In the case of buildings with a strong tectonic component, a double paradox also occurs: On the one hand, the lightweight materials commonly used for cladding are at the opposite extreme vis-à-vis the material nature of the original, and, on the other, the lightness of the new finishings produces a false sensation of dematerialization of the construction element, when actually, their attachment to the original support only serves to thicken it and make it heavier.

The buildings with a strong tectonic component, linked in many cases to certain clearly recognizable architectural movements, are therefore the ones with a higher risk of seeing their inherent compositional, material, and construction characteristics altered. The third chapter will accordingly center, as a case study, on the analysis of how energy-improvement interventions can affect one of those architectural movements: exposed-concrete brutalist architecture.

## 3. Case Study: Brutalism

### *3.1. The Rehabilitation of Brutalist Buildings*

#### 3.1.1. A new Architectonical Style: "Béton Brut" or Brutalism

In the European post-war socioeconomic context, to stimulate the construction industry, the first thing required was to employ materials that were until then used for weapons and military buildings. To do this, it was therefore necessary to find a new way to produce materials and simplify construction processes. This meant a new form of designing architecture. One of the masters of the Modern Movement, Le Corbusier, while retaining some of the fundamentals previously established for architecture, changed direction from the formalism of the international style he had used before the war. The need to adjust to the new reality led him to a new way of conceiving architecture [23].

During the war period, reinforced concrete was the technique most used as a basic element for defensive military architecture [24]. Its resilience to bombardment and the possibility of rapid execution using relatively unqualified labor were the key reasons for using this material, along with the affordability of both the materials and the budget for project execution. There was neither time nor any need to make elements that were not functional. This could be carried out using poured concrete left raw.

Using those military constructions as a reference, Le Corbusier envisaged a way of approaching architecture based, above all, on honesty and rationality, thereby enabling rapid, affordable mass construction of new apartments [25]. The first building evidencing how that material was used and roughly formalized was the Unité d'Habitation, built in Marseille between 1947 and 1952 (Figure 4).

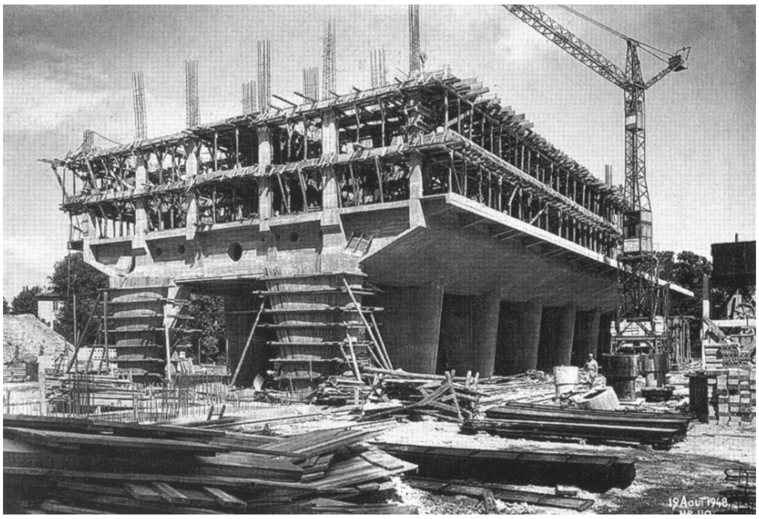


**Figure 4.** Construction process of the Unité d'Habitation in 1947 in Marseille. Source: Gargiani and Rosellini, 2011.

From then on, the use of reinforced concrete employed in this way was fundamental for the development of his work. He built many examples using raw concrete around the world. But perhaps the best place to see how Le Corbusier used this material, taking it to its ultimate consequences, is in the plan and execution of the Monastery of La Tourette (1957–1960). This is due, first of all, to the program set by the Dominican monks requiring simplicity and sobriety and, second, to the need to cut the budget when construction was already under way; the result is the maximum exponent of what *béton brut* or raw concrete architecture came to signify.

After the construction of the Unité d'Habitation in Marseille, the architectural precepts of "brutalism" spread worldwide [26], along with the use of concrete in its *béton brut* form. In the 1950s, Alison and Peter Smithson along with other architects led this movement's introduction in the United Kingdom. Later, during the 1960s and well into the 1970s, this new way of conceiving architecture gave rise to significant examples around the world. Kenzo Tange in Japan or Lina Bo Bardi in Brazil are representatives of that expansion. During this period, the plasticity of the materials during the construction process was exploited, emphasizing the expressiveness of the exposed structural and mechanical elements [27] in the final finish. This marked the beginning of two decades in which brutalist buildings proliferated throughout the world.

This new way of building and conceiving architecture was largely based on the use of reinforced concrete in the most natural form possible. The concrete's plasticity meant it could be adapted to any kind of form. A wooden formwork had to be made to receive the poured concrete according to the pre-set form. That formwork in turn left indications of its nature imprinted in the concrete after the formwork was removed, just like a fossil record or a footprint in the ground. The great resilience of concrete in turn allowed very significant structural elements. Concrete had already been used in previous architectural styles; the major difference was that the concrete's color and texture were left in view, with no intention of hiding their true nature. The honest treatment of the materials made this kind of architecture triumph in the 1960s and 1970s [28].

#### 3.1.2. Need of Intervention in Brutalist Buildings

Beyond the need to improve energy efficiency of buildings, there is a previous problem, which is the characteristic deterioration of exposed-concrete buildings. The evolution of construction techniques meant that increasingly uniform finishes could be obtained; even though the imperfections were deemed inherent to the material, those involved in the respective execution rarely left such issues to chance. Architects and construction managers tried to seek a balance between tolerance regarding discontinuities and control of execution; the fear of falling into excessive elaboration or mannerism that would result in "false rustic" was fiercely debated [29]. At the same time, the use of structural concrete was still novel and required continual revisions of regulations. This is shown by the various regulations that arose regarding calculations and usage of this material [30]. The gradual deterioration inherent to any kind of construction is even more evident in buildings whose structure and enclosure are the same [31]. From a conservation standpoint, the absence of cladding poses a major challenge, as the heritage value in such cases is based on the material nature of the reinforced concrete. Several decades after its installation, the material presents a great deal of deterioration, feeding the common aversion to the look of concrete.

Most of the damage seen in these buildings comes from neglecting the concrete's pathological processes and the lack of proper maintenance. The industry's progress in this sector has shown that many of them required repair interventions [32]. However, cases where conservation criteria are followed are relatively infrequent and rarely documented.

Recent publications confirm that there is more awareness regarding exposed-concrete constructions and a clear interest in establishing action criteria for conservation also in this area. Well-known restorations such as those of the Unité d'Habitation in Marseille (2000–2017) or the National Theatre in London (2011–2015) [33] have shown that to conserve or recover the raw concrete's original appearance, thorough preliminary analysis and careful execution are necessary. Other less-known examples have also shown that interventions can be both respectful and effective [34]. This is why it is necessary to establish some basic principles for all rehabilitation meant to highlight a building's architecture: contextualization of the building by studying its history and the reasons justifying its survival, exhaustive analysis of the architecture and the construction solutions used, and determination of the optimal degree of intervention adapted to the particularities of the building in question.

At present, a substantial number of interventions carried out in buildings with surfaces of exposed reinforced concrete, whether structural or not, are limited to repairing elements. The most common superficial damage in any reinforced concrete construction element is carbonatation, a phenomenon whereby atmospheric carbon dioxide reacts with the concrete's alkaline components, neutralizing the material and leaving the interior reinforcement totally unprotected. The increase in rebar volume due to corrosion generates enormous pressure on the surrounding concrete, causing cracks and, if not repaired in time, subsequent bursting and eventual detachment (Figure 5).

**Figure 5.** Vertical wall of the brutalist Carmelo Balda Fronton building in San Sebastián with some carbonatation damage. Photo: authors, 2019.

The repair process for this superficial pathology is described in European standard EN 1504-3 [35]. Although such occasional repairs try to preserve the original elements, prolonging their useful life, they do not approach restoration from an integrative perspective. Nevertheless, to follow a rigorous methodology does not have to condition the choice of construction techniques or limit to one single criterion the action possibilities.

In any case, it has been seen that even when there is no need to intervene from an energy standpoint, these buildings still present major difficulties when intervening in them, especially on their façades. The perimeter concrete bearing walls comprise the façade, and the latter's texture is provided by the material's form and finish. For that reason, when interventions must be done in such buildings, any change of façade typology or thermal insulation can degrade the original architectural concept (Figure 6).

**Figure 6.** Current state of an isolated repair and a test with repair mortars of different tones on the brutalist Carmelo Balda Fronton building in San Sebastián. Photos: authors, 2019.

#### 3.1.3. Preservation Versus Energy Efficiency

The brutalist architecture style must be valued, and some of those buildings are considered part of the built heritage [36]. But others have not been so recognized and do not benefit from any official protection. This means that, at present, those buildings' architectural configuration can be modified; they can be subject to intervention without any conservation criteria or even demolished, as happened with the Robin Hood Gardens of

Alison and Peter Smithson [37]. Something similar may occur in the city of San Sebastián, where no brutalist building is included in the list of protected buildings [38], even though there are significant examples. And it is likewise the case in many places worldwide, where brutalism is still not considered a historic architectural movement. In this regard, there is a need to value such buildings as part of the built heritage as soon as possible.

We also realize that these buildings have poor energy performance. This is because, among other reasons, energy efficiency was not an issue when they were designed. However, whether protected or not, it is considered that renovation should be conducted with a view to improving their energy performance. The case of brutalist buildings is a clear example of the need to break the aforementioned dichotomy by ensuring their protection while also improving their energy performance. Few case studies have been conducted to date on such buildings, though as this architectural movement becomes increasingly valued, the number of indicative interventions and energy rehabilitations is rising [39].

Furthermore, the preservation and energy improvement of brutalist buildings is complex, particularly due to their construction design. In many cases, there are wall finishes or glassed surfaces that form part of the enclosure besides the concrete itself. In such cases, improving the enclosure's characteristics to reduce demand may be easier, along with intervening in and improving the performance of the active heating and cooling systems. But all those elements are not the ones that determine the heritage values for this kind of buildings. Finding the right way to insulate a building thermally without negatively affecting its architecture and material nature is a difficult equation to solve (Figure 7).

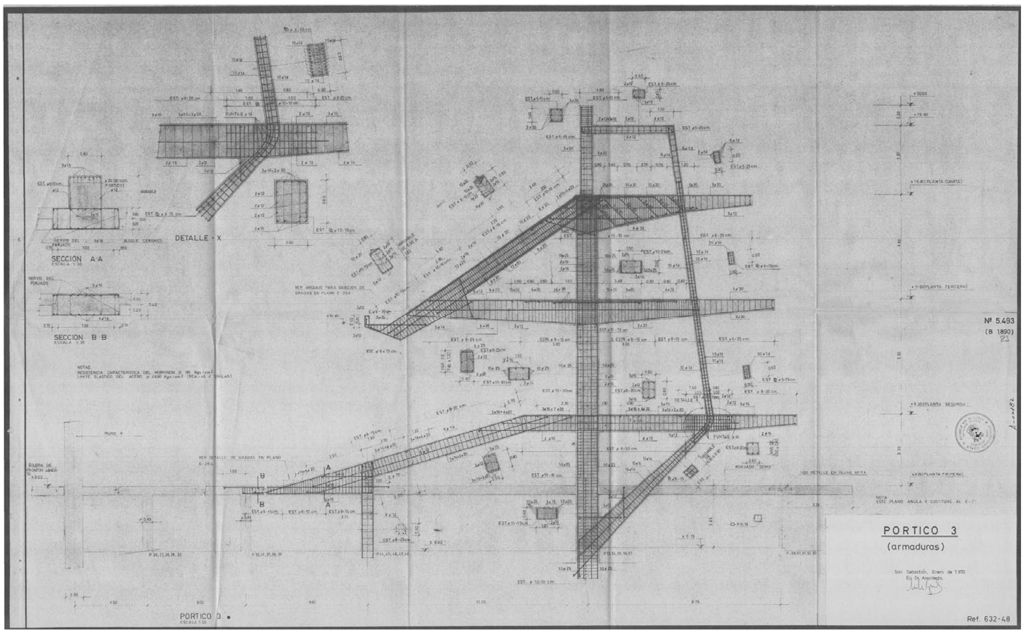



**Figure 7.** Original plan where the structure and final finish are the only construction element. Carmelo Balda Fronton, L.J. Arizmendi, San Sebastián, 1969–1974. Source: Municipal Archive of the City of San Sebastián.

In any case, magnificent examples can be found in which the rehabilitation intervention was able to integrate the necessary energy improvement of a brutalist building without altering its architectural values. One of them is Ernö Goldfinger's Balfron Tower in London, protected since 1996, which was recently renovated by Studio Egret West [40] with a focus on "constructive conservation" [41] and maximum respect for the brutalist aesthetic. To preserve the exterior appearance, originally resolved with structural and construction elements in exposed concrete, the interior faces of the exterior walls were insulated along with the floors and ceilings of the interior spaces to eliminate the thermal bridges. Another example is the conversion into a hotel of Marcel Breuer's Pirelli Building in New Haven, USA, carried out by Becker + Becker Associates, which, as in the above case, scrupulously preserved the building's external tectonic features, solely intervening in its interior. An opposite approach worth mentioning is the renovation of the Five Manhattan West building in New York. In that intervention, the architects opted to preserve the original brutalist structural arrangement while adding a new exterior skin that completely hides it.

We can therefore see that there is a problem when constructions included in the built heritage require an energy intervention. The problem is not exclusive to brutalism; it has happened in many cases of protected historic buildings, especially when interventions are required in elements of the exterior skin because, in most cases, those are the construction systems that determine the building's heritage value [42].

### 3.2. Application of the Methodology in Three Brutalist Buildings

Three examples of brutalist buildings built in San Sebastián and its surrounding area were selected (Figure 8) with the aim to apply the proposed methodology and to check and compare the results obtained. Even though these are three excellent examples of *béton brut* construction built in the 1960s and 1970s, they lack any kind of protection, as they have not been officially assigned any heritage value whatsoever. Due to the period in which they were built and because they have not undergone any major rehabilitation interventions, their energy performance is deficient. Each of them is briefly described below.

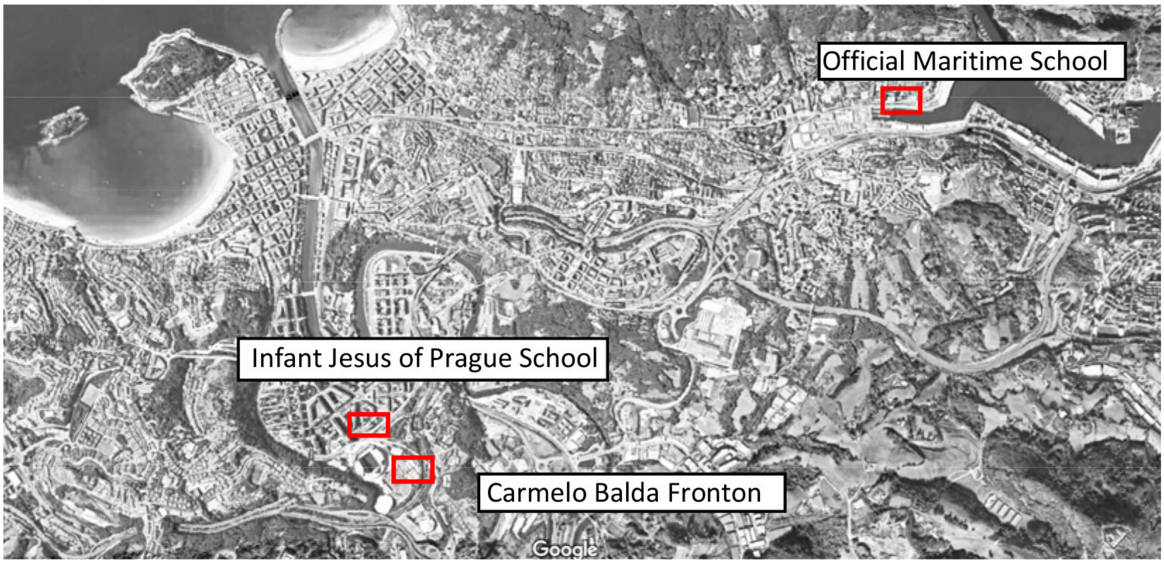



**Figure 8.** Three cases of brutalism in San Sebastián. Source: Google Maps.

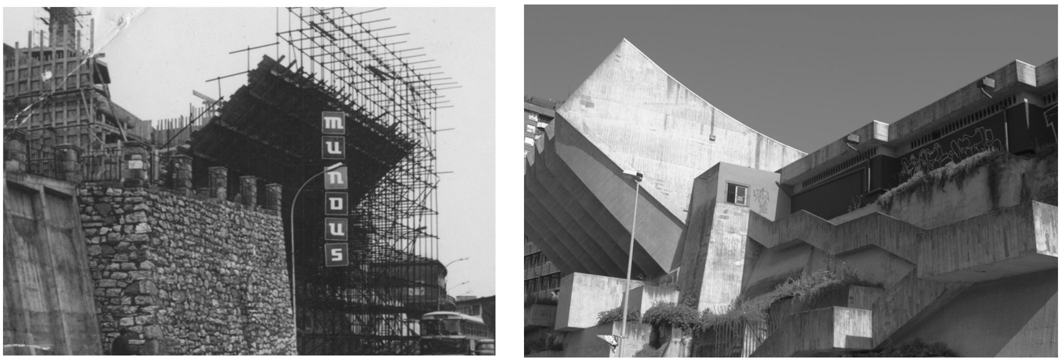
#### 3.2.1. Building 1: Infant Jesus of Prague School: M. Oriol and G. Lafuente (1965–1967)

The first building in the brutalist style built in San Sebastián was the Infant Jesus of Prague School [43]. The project designed in 1965 by Miguel de Oriol and Gregorio Lafuente and built in the following years used *béton brut* and was the first totally brutalist building to appear in the city (Figure 9). At present, it is not protected, even though it signifies a radical change in the conception and style of architecture used until that time in Spain. This is a clear example of the incursion of the new architectural movements introduced from Europe. Its value therefore stems from its originality as well as the expressive solution of its architecture. The building maintains the original function for which it was designed: a Catholic school with a religious residence.

**Figure 9.** Infant Jesus of Prague School, M. Oriol and G. Lafuente, San Sebastián, 1965–1967. Photos: authors, 2019.

3.2.2. Building 2: Official Maritime School in Pasaia: J.L. Zanón and L. Laorga (1966–1968)

Between 1963 and 1968, the architects José Luis Zanón and Luis Laorga designed and built seven maritime schools in different cities in Spain; one was the Official Maritime School in Pasaia [44]. The building's materiality is reflected in the use of concrete as a structural and finishing element. Special mention should be made of the auditorium composition in the form of a folded sheet, with the seating on a structure projecting 8.50 m outward (Figure 10). This second case is also not protected by current heritage legislation. It represents the second case of brutalist architecture in the region. Its architectural arrangement established by different expressive volumes corresponds to its use as a maritime school, recalling the forms and functions of a boat. The use of reinforced concrete as the structure and enclosure of most of the building recalls other buildings designed around the world during the same period.

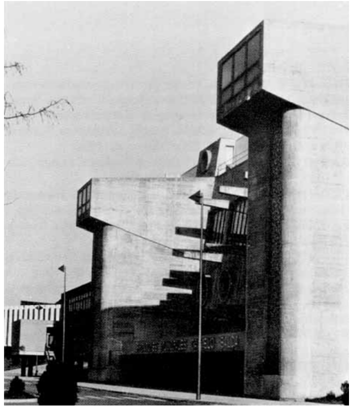



(**a**) (**b**)

**Figure 10.** Official Maritime School, J.L. Zanón and L. Laorga, Pasaia, 1966–1968. (**a**) Source: Municipal Archive of the City of Pasaia. (**b**) Photo: authors, 2019.

3.2.3. Building 3: Carmelo Balda Fronton: L.J. Arizmendi (1969–1974)

For this building design, the architect chose to use the brutalist style as a local response to the incipient international movement [45]. The two previous cases had already been built and probably influenced the architect's choice. Concrete is used again both as a structural and finishing element, resulting in a large basic and compact volume (Figure 11). This third case is also not protected by either local or regional heritage legislation. Its structure and image nevertheless project this brutalist style so representative of the period. Even though it has undergone several transformations over the years, with various adjacent buildings put up that have hidden the original construction unity, it is a clear example of the value that should be given to such buildings. It still maintains its original use as a pelota court, to which other administrative and sport uses have been added.

(**a**) (**b**)

**Figure 11.** Carmelo Balda Fronton, L.J. Arizmendi, San Sebastián, 1969–1974. (**a**) Photo: authors, 2019. (**b**) Source: Municipal Archive of the City of San Sebastián. Photos: authors, 2019.

As established in the proposed methodology in Section 2.2, because these are singular buildings that are non-residential and unprotected, the first step consists of analyzing their vulnerability degree, establishing the BVD value for each of them. This is summarized in Table 4.

**Table 4.** BVD application results.

| | | **Indicator** | **Weight** | **Grade** | **Value** | **Building 1** Jesus of Prague School | **Building 2** Official Maritime School | **Building 3** Carmelo Balda Fronton |
|---|---|---|---|---|---|---|---|---|
| BVD—Building Vulnerability Degree | CR | Richness of composition and materials | 20% | Very High | 20 | | | |
| | | | | High | 15 | | | |
| | | | | Medium | 10 | | | |
| | | | | Low | 5 | | | |
| | | | | Very low or none | 0 | | | |
| | CQ | Construction quality | 15% | Very low or none | 15 | | | |
| | | | | Low | 11 | | | |
| | | | | Medium | 7 | | | |
| | | | | High | 3 | | | |
| | | | | Very High | 0 | | | |
| | AD | Alteration Degree | 15% | Very low or none | 15 | | | |
| | | | | Low | 11 | | | |
| | | | | Medium | 7 | | | |
| | | | | High | 3 | | | |
| | | | | Very High | 0 | | | |
| | CD | Construction deterioration | 15% | Very High | 15 | | | |
| | | | | High | 11 | | | |
| | | | | Medium | 7 | | | |
| | | | | Low | 3 | | | |
| | | | | Very low or none | 0 | | | |

**Table 4.** *Cont.*

| | | Indicator | Weight | Grade | Value | Building 1 Jesus of Prague School | Building 2 Official Maritime School | Building 3 Carmelo Balda Fronton |
|---|---|---|---|---|---|---|---|---|
| BVD—Building Vulnerability Degree | EQ | Energy qualification | 15% | G | 15 | | | |
| | | | | F | 11 | | | |
| | | | | E | 7 | | | |
| | | | | D | 3 | | | |
| | | | | ≥C | 0 | | | |
| | RQ | Recognized quality | 8% | Exceptional | 8 | | | |
| | | | | High | 5 | | | |
| | | | | Medium | 3 | | | |
| | | | | Low or none | 0 | | | |
| | AR | Authorship relevance | 8% | Exceptional | 8 | | | |
| | | | | High | 5 | | | |
| | | | | Medium | 3 | | | |
| | | | | Low or none | 0 | | | |
| | AI | Need to improve accesibility | 4% | Yes | 4 | | | |
| | | | | No | 0 | | | |
| | | | | | | 64 | 64 | 57 |

Once the BVD values are obtained, the RPD value is also obtained, as indicated in Table 5. It defines the protection degree depending on the resulting vulnerability. Buildings 1 and 2 obtain an RPD value of IV, while building 3 obtains a value of III.

**Table 5.** RPD results for three brutalist buildings.

| | | RPD | Building 1 Jesus of Prague School | Building 2 Official Maritime School | Building 3 Carmelo Balda Fronton |
|---|---|---|---|---|---|
| BVD | 0–20 | **I** | | | |
| | 21–40 | **II** | | | |
| | 41–60 | **III** | | | 57 |
| | 61–80 | **IV** | 64 | 64 | |
| | 81–100 | **V** | | | |

### *3.3. Discussion of Results*

After determining the protection degree of each building, the criteria for intervention in the different construction elements of each of them are analyzed, following what is established in Table 3. Among those criteria is that concerning the most suitable energy intervention according to the principles of the TEIBH. Bearing in mind that flexibility is needed when interpreting the criteria set out in the tables, both the energy intervention proposals and the preliminary studies that value them are adjusted to each specific case.

Regarding the façade's composition and volumes, occasional modifications are allowed in the three buildings, as long as they are justified by the proponent of the intervention and accepted by those in charge of applying the methodology. In principle, the architectural composition or volumes of the three buildings can be slightly modified. In the case of Building 2, the roundness of its volumes makes it more sensitive to any change, while the other two cases, due to their size and form, seem less vulnerable to accepting certain modifications.

As for color, in cases 1 and 2, the original chromatics should be respected or recovered if altered over time, while in case 3, a change of tone would be allowed after prior analysis. In any case, in the particular case of reinforced concrete brutalist buildings, it seems logical to maintain the natural color of the raw applied material. Something similar happens with the materiality, possibly the most identifying feature of this architectural style, though at the same time, it is vulnerable and delicate. The decision on how to intervene in the bare concrete walls should be studied very thoroughly, and the conclusion in most cases will possibly be to conserve them, subjecting them when necessary to surface repairs that recover and preserve the original appearance. In the case of the three analyzed buildings, the intervention criteria determine that the walls' materiality should be conserved in the two first cases, though it can be altered in the third after prior analysis. In the latter case, we find that the two main façades still have their original concrete walls, while the other two façades have been partially hidden after the addition of new volumes. So, in the case of building 3, it seems natural that the preliminary study concludes by recommending conservation without any possible alteration of the two original main façades, only allowing changes in the ones that are partially hidden. The latter intervention should, in any case, be reversible and allow future recovery of the original walls.

In the case of the windows and other gaps, replacement of the frames and glass is permitted in the three cases as long as the change does not imply a major formal disfiguration. Building 1 has the particularity of having a large curtain wall on one of its façades, with a very high formal and compositional value, which ought to be maintained. In the event that its replacement becomes necessary to improve the energy balance or because of extreme deterioration of its frames and glass, the new closure should respect the original chromatics and arrangement. As for the rest of the façade's construction elements, none of the three buildings present major alterations, whereby the recommendations on how to act in those elements are set out in Table 3. In the case of building 1 and due to its poor state, the lattices on one of the façades were recently replaced by others harmoniously integrated into the façade.

With respect to the roofs, certain modifications are permitted in the composition and volumes of the three buildings. As for the finishing solution, in the first two cases, the proposed solution would have to be analyzed, while in the third case, the change of covering material would be totally free. As this is the most exposed construction element and given the time since their construction, the roofs of the three buildings have already been renovated. In the cases of buildings 1 and 2, both the original composition and the covering type have been respected, while in building 3, a partial modification can be seen in both the form of the roof and the finishing material.

Once the main architectural and construction elements that might condition an eventual rehabilitation action are analyzed, it only remains to determine the energy intervention level (EIL), depending on the protection degree obtained in each of the cases, as established in the TEIBH. We can thus see that in the three buildings, the EIL would be 3. That is, a selective intervention would be put forward, which would require analysis of the compatibility between the proposed energy measures and the architectural features to preserve in each case. In the three cases, active measures could be proposed to improve and update their climatic arrangements. Conversely, when proposing passive solutions, the intervention area concerned would have to be studied. In buildings 1 and 2, action should be solely on the roof and in the recesses, while in the case of building 3, action could also be permitted on the walled part. After exhaustive analysis of the three examples subjected to study, it seems clear that the exterior materiality of the reinforced concrete walls should be preserved in all cases, except in the two façades of building 3 that were already substantially modified. Also, in the three cases, it seems feasible to add insulation to the interior face of the façade walls, as they have been lined with diverse materials since the time of their construction.

In all cases, replacement of the original architectural elements is necessary when the aim is to prevent gradual deterioration and maintain the buildings' functionality. It is considered reasonable to use modern materials and techniques whose nature is different from those originally used. In any case, according to the criteria set out in the successive international charters for conservation and restoration [46], the means used should alter neither the appearance nor the general character of the building subject to intervention. On the one hand, the restoration of the deteriorated concrete surfaces should avoid excessive contrast between the repaired parts and the original parts of the surface. And, on the other, the renovation of the exposed-concrete elements by adding thermal insulation and cladding should be questioned and all the more so when it implies an irreversible loss of the building's inherent heritage values.

## 4. Conclusions

There are two issues that now seem beyond any doubt: on the one hand, the necessary containment of global warming through environmental protection and, on the other, the conservation of the architectural heritage that humanity has left as a legacy over the course of history. These two questions at times have seemed to clash when actions meant to improve the environment confront the possibility of losing inherited values. In 1987, the Brundtland Commission set out a similar paradox, bringing together two terms that in principle came from contradictory departure points—development and sustainability: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [47].

This same concern applies to the construction sector when energy interventions jeopardize the heritage values of the building stock, posing the dichotomy of how to resolve conservation through action. Current legislation avoids confrontation, permitting non-intervention in buildings with acknowledged heritage value. In the most obvious cases, the exceptional architectural characteristics of certain buildings mean that any energy intervention makes no sense whatsoever, also bearing in mind their very slight impact on the territorial energy balance. But that logic of exceptionality should not be assumed as the norm; criteria to break the dichotomy between intervention and preservation should be established, as defended in the TEIBH.

The proposed methodology aims to balance those two aspects, seeking a scale for energy intervention and the protection of built heritage instead of opting to simplify or even avoid the problem. Based on a previous methodological proposal by the authors of this article solely addressing the façades of unprotected residential buildings, what is now proposed is its adaptation and extension to all types of buildings including, among others, energy intervention criteria. Although current legislation does permit the exclusion of protected buildings, it is considered vital to include them in the methodological analysis in order to decide what to do with them from an energy standpoint. In some cases, this analysis may advise not intervening under any circumstance, while in other cases, a range of possibilities could be opened, which should be studied on an individual basis. At the other extreme, in the case of unlisted buildings, the fact that their heritage value has not yet been considered does not mean that many of them cannot be listed in the future. An energy intervention that does not take into account the architectural virtues of the original building may eventually irreversibly mortgage any future valuation.

Brutalism, the architectural style chosen as case study, represents one of the clearest examples of an undervalued typology barely acknowledged in the protection lists. Besides including a large number of buildings around the world, it represents a very singular type of architecture and is an international style characteristic of a certain era. This style, which, despite being vilified in the decades after its emergence and development, is now experiencing maximum interest because its heritage value is beginning to be recognized. UNESCO's recognition of the French city of Le Havre as world heritage in 2005 is a clear example of this [48]. The reconstruction in exposed concrete of the city center carried out by Auguste Perret after the Second World War, much criticized and vilified until quite recently by the city's own inhabitants, achieved one of the maximum heritage distinctions sixty years later. Although few brutalist buildings are listed, it is hence foreseeable that a time will come when it is considered a style to preserve and a representative of a historic period of architecture and construction that is unlikely to be repeated. The three buildings in the San Sebastián area selected for application of the methodology represent those many examples of buildings that have been undervalued over the years. Although they currently lack any kind of protection, it is foreseeable that they may end up being included in the protection lists. It is therefore fundamental to analyze how any energy-improvement intervention can eventually affect their architectural characteristics.

In short, integrated application of the TEIBH and the CRIRB+ methodology in buildings serves to classify their degree of vulnerability when rehabilitation intervention is planned, to grant a certain degree of protection to each building, and to establish the intervention criteria in each case. This methodology is designed to be applied to any kind of building, regardless of the respective characteristics, use, and heritage value. It is, of course, an open methodology with a high degree of flexibility, allowing it to be interpreted and adapted to each case.

The methodology is meant to help regulate rehabilitation interventions in any municipality and to facilitate the work of officials from the corresponding administration who draft what could be called a rehabilitation catalog. That catalog would establish the intervention criteria that the rehabilitation plan of any building should comply with, depending on its vulnerability degree and protection degree. The materials and the solutions for construction and energy efficiency improvement proposed in the corresponding rehabilitation project would have to meet the requisites set out in that catalog. Ultimately, the methodology is designed to be an effective tool that facilitates decision making by the project's planners and helps municipal technical officials oversee the different rehabilitation proposals.

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