DAVID PUBLISHING
From Knowledge to Wisdom

ISSN 1934-7359 (Print)
ISSN 1934-7367 (Online)
DOI:10.17265/1934-7359

Journal of Civil Engineering and Architecture

Volume 17, Number 11, November 2023 (Special Issue)

Journal of Civil Engineering and Architecture

Special Issue
Volume 17, Number 11, November 2023 (Serial Number 192)

David Publishing Company
www.davidpublisher.com

Publication Information:

Journal of Civil Engineering and Architecture is published monthly in hard copy (ISSN 1934-7359) and online (ISSN 1934-7367) by David Publishing Company located at 3 Germay Dr., Unit 4 #4651, Wilmington DE 19804, USA.

Aims and Scope:

Journal of Civil Engineering and Architecture, a monthly professional academic journal, covers all sorts of researches on structural engineering, geotechnical engineering, underground engineering, engineering management, etc. as well as other issues.

Manuscripts can be submitted via Web Submission, or e-mailed to civil@davidpublishing.com or civil@davidpublishing.org. Submission guidelines and Web Submission System are available at http://www.davidpublisher.com.

Editorial Office:

3 Germay Dr., Unit 4 #4651, Wilmington DE 19804, USA

Tel:1-323-984-7526; Fax:1-323-984-7374

E-mail: civil@davidpublishing.com; civil@davidpublishing.org; shelly@davidpublishing.com

Abstracted/Indexed in:

Cambridge Science Abstracts (CSA)
Ulrich's Periodicals Directory
Chinese Database of CEPS, Airiti Inc. & OCLC
Summon Serials Solutions, USA
China National Knowledge Infrastructure (CNKI)
Turkish Education Index
Google Scholar
ProQuest, USA
J-Gate

Subscription Information:

$720/year (print)

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Modern Architecture and Color

Conservation of 20th century building materials and surfaces

In 20th century architecture, color plays different roles determining both aesthetic value and significance of modern buildings: from a tool of spatial qualification, to an element connected to social, pedagogical or healing aspects, to a feature of natural and urban landscape. The legacy of this season of experimentation and innovation is today dealing with the fragility of building materials and surfaces, that are progressively changing the heritage in the eyes of the observer.

The theme of conservation and preservation of modern polychrome surfaces highlights aspects and criticalities, both theoretical and operative, that require specific in-depth studies.

The special issue of JCEA brings together relevant ongoing researches and recent studies presented as part of the International Research Seminar "Modern Architecture and Color. Knowledge and conservation of 20th century building materials and surfaces"[1] promoted by the Research Cluster "He.Modern - Heritage culture and Modern design" of the Iuav University of Venice, held in Venice on 28th October 2022.

Each paper is based both on the historical analysis of the archival documentation and the *in situ* investigation of relevant buildings characterized by an experimental use of color, understanding their qualities and providing new methods of characterization of materials and techniques, new approaches for the analysis of alteration and degradation phenomena, and innovative strategies for the preservation and maintenance program.

The studies reflect the interdisciplinary nature of the international research intended as an opportunity for dialogue between Italian and foreign scholars on case-studies and topics not yet investigated, with the aim of making a contribution to knowledge and preservation of modern architectural heritage.

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Department of Architecture and Arts, Università Iuav di Venezia

[1] International Research Seminar "Architettura e colore. Conoscenza e conservazione di materiali e superfici del XX secolo / Modern Architecture and Color. Knowledge and conservation of 20th century building materials and surfaces", Aula Magna Tolentini, Università Iuav di Venezia, 28th October 2022. As part of the research and educational activities of SSIBAP - Post-graduate School of Specialization in Architectural and Landscape Heritage, and research cluster He.Modern - Heritage culture and Modern design. Under the auspices of SIRA – the Italian Society for Architectural Conservation/Restoration, DOCOMOMO Italy, FOAV Federazione Regionale Ordini Architetti Pianificatori Paesaggisti e Conservatori del Veneto, and Ordine degli Architetti, Pianificatori, Paesaggisti e Conservatori di Venezia. Organizing Committee: Sara Di Resta, Greta Bruschi. Scientific Committee: Paolo Faccio, Susanna Caccia Gherardini, Angelo Maggi, Marco Pretelli, Pierre-Antoine Gatier, Giacinta Jean.
The outcomes of the International Research Seminar are collected in this JCEA special issue, edited by G. Bruschi, S. Di Resta, P. Faccio.

Preface

Modern Architecture and Color. University, Research, Education.

Benno Albrecht
Rector, Università Iuav di Venezia

The special issue of the *Journal of Civil Engineering and Architecture* focuses on the activities of the research cluster "HeModern - Heritage, culture and Modern design" of the Università Iuav di Venezia, that consists of national and international scholars, institutions and companies in the field of architectural preservation.

The Department of Architecture and Arts is the place where the investigation activities are fuelled by the discussion and collaboration between different cluster research, that carry out multidisciplinary paths interpreted not as a sum but as an interaction of skills.

The research cluster "HeModern" investigates tools and methods of preservation of modern heritage, from design items to buildings, from cities to territories.

Architectural conservation, science and technology, history, design and urban planning are the subject areas that converge on the themes explored in the special issue.

The selected papers address the theme of color in 20th-century as a result of the international research seminar "Modern Architecture and Color. Knowledge and conservation of 20th century building materials and surfaces", held in Venice in October 2022. The main topics include the role of color in the design path and in photographic representation; the knowledge of modern building materials between polychromy and polymateriality, tradition and innovation; sustainable diagnostic methods for modern heritage; new strategies for conservation intervention.

Modern and contemporary heritage represents the legacy of the most important architects of the 20th century. The preservation of their works involves research and education, and represents one of the cultural challenges that the Università Iuav di Venezia has decided to take up.

***Modern Architecture and Color. Knowledge and conservation of 20th century building materials and surfaces*, program of the international research seminar, 28th October 2022, Venice (Italy).**

Journal of Civil Engineering and Architecture

Special Issue

Volume 17, Number 11, November 2023 (Serial Number 192)

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doi: 10.17265/1934-7359/2023.11.001

Color, Time, Layering and Preservation

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Abstract: The preservation of polychromy in 20th century architecture is here considered from both theoretical and operational perspectives. A further theme is that of polymatericity, which addresses issues related to the experimental context with reference to the materials and technologies employed. The passage of time and the lack of durability of innovative materials, the transformations and the presence of forms of alteration and degradation, pose problems related to the will and the possibility of preserving layering, without falling into the restoration of the presumed original document, in relation to the authorial project documentation and the underlying theories.

Key words: Polychromy, polymatericity, 20th century architecture, innovative materials, layering, preservation.

1. Introduction

The recognition of the role of color in the architecture of the past was first expressed in 1832 by Quatremère de Quincy in the *Dictionary of Architecture* [1]. The theme of color, beginning with archaeological findings, became part of the theoretical debate in architecture and, therefore, was also faced by the many architectural movements that animated the Modern Movement.

Giulio Carlo Argan (1909-1992) wrote that color should not be a mere decorative component, but rather a fundamental element of formal structure. Argan stated that architecture and color must be conceived and designed simultaneously. This clarification highlights an extraordinarily complex issue for the preservation of polychromy architectures nowadays. Indeed, we cannot neglect to consider the role of time, whose action shapes the architecture, transforms the surfaces and sometimes modifies or deletes the original colors.

Argan, referring to movements and actors that characterize the early 20th century, identified "De Stijl" as a key episode in the history of contemporary art [2].

2. The Color Issue and the 20th Century Architecture

Theo van Doesburg (1883-1931) is known as the founder and leader of "De Stijl". In 1924 he published the essay "Toward a Plastic Architecture" in which he outlined 16 points on the neo-plastic vision of modern architecture. The 14th and 15th points faced the color issues. In particular, the 15th point explains: "The new architecture is anti-decorative. Color (and this is something the color-shy must try to grasp) is not a decorative part of architecture, but its organic medium of expression" [3]. Van Doesburg also wrote: "We have given color its rightful place in architecture and we affirm that painting separated from architectural construction has no right to exist" [4].

Van Doesburg exemplifies this concept in the study of the *Maison Particulière* where volumes are emphasized with the use of the primary colors: blue, yellow and red (Fig. 1).

In 20th architecture, color becomes a very important theme expressed in the poetics of the masters [5].

Le Corbusier constitutes the best-known example to emphasize the fundamental importance of color in architecture. He proposed the concept of *Polychromie Architecturale*, introducing the *claviers de couleurs* (keyboards of colors). The first *palette* of 1931, which would be used by the company *Salubra* for a wallpaper collection, included 43 hues in 14 sets of solid colors and calibrated tones. Le Corbusier, based on previous

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Fig. 1 Theo Van Doesburg, Cornelis van Eesteren, *Maison Particulière* 1923.

experience, including Maison La Roche (1924), created color combinations that recalled studies on optical sensations and moods [6].

In 1959 a second collection completed the first *Polychromie Architecturale* and consisted of 20 additional bright colors and 63 shades, used in the *Unité d'Habitation* and at the *Maison De L'Homme* in Zurich. The harmonization of the various colors in the palette was compared to the role of a piano master. As a further supplement to the previous comment Le Corbusier writes "It was necessary to prevent colors from reducing the aesthetic value of the walls [...]. Therefore, an authoritative assumption: eliminate colors that can be considered non-architectural. Better yet: identify, choose colors that can be called exclusively architectural, and limit yourself to them. These are more than enough!" [7] (Fig. 2).

These synthetically reported examples are followed by later experiences in which color also finds a relationship with the surrounding landscape. The Italian case of Edoardo Gellner provides an important topic. In the former ENI village of Borca di Cadore, Gellner indeed introduces a selection of colors that accompany the changing of nature in the different seasons [8] (Fig. 3).

Fig. 2 Le Corbusier's apartment in Paris after renovations (Scaramuzza, 2018).

Fig. 3 E. Gellner, former ENI village in Borca di Cadore (Faccio, 2018).

3. Conclusions

The examples given, though fragmentary, are nonetheless significant in highlighting conservation issues. The possibility of reading layers over time, and the role of time shaping and transforming architecture (and surfaces), seems to be contradictory to theories of color in architecture, which would seem to suggest the need to innovate/restore polychromy in its full and total legibility.

It is necessary to mention the conservation of materials, in relation to the experimental techniques employed in the twentieth century, where technological innovation also assumes an important role related to both color and polymatericity.

In this context, therefore, fundamental issues arise with which the preservation of twentieth-century architecture

has to deal. The question is whether to pursue the approach of preserving the layering over time or to prioritize the memory of theoretical assumptions and design outcomes that constitute a fundamental part of the Modern Movement.

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Journal of Civil Engineering and Architecture 17 (2023) 536-538
doi: 10.17265/1934-7359/2023.11.002

Restoring 20th Century Architecture: Few Words about a Possible Theory

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Abstract: The restoration of twentieth-century architecture has led the discipline to develop a solid theory which, considering the complexity of new issues to be resolved, can provide useful instruments, above all critical ones, for operational practice.

Key words: 20th century architecture, restoration, preservation, heritage.

1. Introduction

An expansion of the boundaries of what can now be recognized as heritage opens up not only linguistic conflicts about what is or is not defined by that term, but also what restoration methodologies can or should be [1] [1-4]. If these conflicts exist within questions concerning already established operational practices for architecture considered "historical", even within the European context alone, the disagreements are amplified if the gaze shifts to 20th century heritage [5]. In order to address and establish intervention practices, it seems more necessary than ever to develop an adequate theoretical approach to problems that 20th century architecture poses to the restorer today. Especially at a time when various technocratic drifts have pushed the discipline mainly towards micro-specialist solutions, when in fact the problems posed involve far more complex critical issues, first and foremost the intertwining of recognition, memory and political use of the past [6].

2. Authorial/Anonymous Architecture

Moving into the 20th century, the first issue that arises is how different artistic movements and geographical contexts approached the question of surfaces and color. We need only recall the differences between De Stijl and Constructivism, between Bauhaus and Dadaism. The other fundamental aspect is that this problem arises in different ways between authorial architecture, with the added difficulty of the transition to icon, and anonymous buildings (a term preferred to "minor", but there is much to discuss in this sense, too) [7].

Fig. 1 Le Corbusier, Asile flottant, Paris (2016).

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[1] On the evolution of the concept of heritage note at least: Babelon, J.-P., and Chastel, A. 1995; Poulot, D. 1998; Caccia Gherardini, S., and Olmo, C. 2015. For a general overview of the problem see also Swenson, A. 2013.

The works of Le Corbusier (Fig. 1), Mies van der Rohe or Terragni have not only undergone multiple restorations, but in these cases the most deeply rooted disease in the restoration culture offers an almost paradoxical example. The search for the origin, the cult of traces left behind by customs and time, and the transition from testimony (of an artistic conception, a constructive culture, a cultural and social environment), gives way to an almost ontological value of the work.

These problems are compounded by an additional one that further complexifies the definition of a theoretical framework: the reproducibility was made possible by materials and techniques throughout the 20th century [8].

Moreover, the prevalence of the photographic image as the primary source of restoration over the materiality and stratification of interventions and uses of the work has resulted in aesthetic precaution prevailing over heritage precaution [9, 10].

The problem of color, materials and more generally surfaces in 20th century architecture finds answers articulated on a case-by-case basis, as also demonstrated by the essays within this volume, which well exemplify the complexity of the matter especially in terms of research and practice (Figs. 2 and 3).

A starting point could be to transfer the complexity of the issues listed above to a testing ground using the arguments and procedures of microhistory[2] [11, 12].

3. A Possible Theory

The first characteristic that may pertain to what could be defined as a potential micro-restoration [13] is the possibility of proposing a scientific approach in the strong sense of experimental science, highlighting causal links from small to large scale. But perhaps the real issue concerns the sources. The illusion of the mirroring of reality does not belong to micro-history: what is interesting is the presence of the past in our contemporary world, that is the set of sources that represent the "real" for the historian and the restorer. In this sense, micro-history goes beyond the traditional criticism of sources: the problem becomes the textual, as well as material, construction of the source, its uses over time, its conservation, and the consistency of its distribution with respect to other documents.

The reflection should be shifted to what it means to talk about micro-restoration, the plan shifts to textual construction, to the construction of the fact, starting with a review of the usual approaches to the debate on documentality [14].

Fig. 2 V. Garatti, R. Gottardi, R. Porro, Las Escuelas de Arte, La Habana (2019).

Fig. 3 J.-F. Zevaco, Thermal Bath Station, Sidi Harazem (2023).

[2] There is a well-established bibliography on microhistory, among many see Revel, J. 2006; Vito, C. G. 2015.

Criticism of the sources, whether paper or "material", does not make the investigation "scientific" but is a pre-condition, today more than ever, for the restorer's cognitive and decision-making process to move from the extremely delicate relationship between awareness of what they reveal to us today and knowledge of their origin. Sources are in fact social productions that must be decoded as such.

The relationship between investigations, research, surveys and studies is far from a simple problem and is constructed in the concatenation of the different work phases and their placement in a hierarchy, while there is a very strong risk of evolutionism and/or descriptivism in these transitions. The problem of how to structure a historical-critical investigation of 20th century buildings with the aim of clearly revealing the building's physiognomy, nature and characteristics, not without declaring any gaps that may have emerged in the cognitive process, is anything but trivial and, to date, is a largely underestimated problem [15].

4. Conclusions

In restoration, there is no theory of oblivion, of what has been forgotten, why and especially whether it should remain so. Whatever architecture is restored, what does not exist has a hermeneutic force almost as much as the traces that can be found in its material. Referring to the heritage of the 20th century, all these cues have to be measured against an architecture that is experiencing a quantitative leap never before seen in history, and coming to terms with the question of reproducibility, whose sources are on the one hand exorbitant and on the other hand repetitive, with the consequent undermining of the tools and methods of traditional restoration.

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Journal of Civil Engineering and Architecture 17 (2023) 539-541
doi: 10.17265/1934-7359/2023.11.003

The Colors of the Eiffel Tower: A Case Study

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Abstract: Architectures undergoing restoration often have numerous layers of color related to their history and previous interventions. Each layer takes on its own precise meaning related to a specific history and cultural context. The case of the Eiffel Tower becomes significant in illustrating past events and designing future intervention.

Key words: 20th century architecture, Eiffel Tower, colors, history, preservation.

1. Colors of 20th Century Architecture

There are many ways to talk about color in architecture:

- Color of the designed architecture
- Color of the built architecture
- Color of the architecture reproduced and broadcast
- Color of the urban and landscape context
- Modified color of the architecture, before the color of the restored architecture

It all adds up to the color of the architecture.

Each of these colors represents a moment in the history of a project and of an architecture, its transformation, the techniques of the image and the evolution of its reception. Each of these colors needs to be analyzed before they can all be confronted. Together they form a coherent materiality, dissonant or shifting materialities, to perceive a real or dreamed about color.

2. The Eiffel Tower: An Example

The Eiffel Tower, designed by Gustave Eiffel for the 1889 Universal Exhibition in Paris and a founding symbol of modernity, illustrates all these issues. The 20th repainting campaign[1] currently underway has provided an opportunity to analyze the history of its colors in order to define a heritage repainting project: archives research, surveys by restorers (Fig. 1), analysis by the Laboratory (LRMH), health constraints on lead paint.

Fig. 1 Eiffel Tower, picture of a stratigraphic survey detail.

3. Color of the Designed Architecture

3.1 The Prussian Blue Tower

A complex structure designed by engineers from the Eiffel design office is expressed using the codes for representing its material. Built of iron, it is designed and colored in blue, a hue that identifies ferrous

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[1] The Eiffel Tower is the property of the City of Paris and its management is untrusted to SETE. The main Contractor for the 20th repainting campaign is Agence Pierre-Antoine Gatier, represented by Marion Gauchard, architecte, project director.

materials. Since the end of the 18th century, the colored representation of the material of modernity has used a new pigment, the Prussian blue. It categorizes iron, without claiming to identify strictly the alloy chosen by Eiffel, puddled iron. The Musée d'Orsay collections include drawings of the Nice Observatory designed by Charles Garnier, rigorously colored in blue to document the use of puddled iron. In 1889, however, the engineer's mastery of the nuances of blue mixed with the red of carmine and the black of Indian ink enabled him to express the major materials of metal construction, iron, cast iron and steel.

4. Color of the Built Architecture

4.1 The Venetian Red Eiffel Tower

The black-and-white photographs taken by the Chevojon studio and those of the photographers who followed the gradual construction of the Tower cannot convey the color. We need the records of the paint supply, which specifies the use of Venetian red pigment. After the Tower's inauguration, the chromolithographs produced spectacular images of a red tower. For Gustave Eiffel, the construction of the Tower was the culmination of the construction processes used on the great bridges' pylons. The parts were systematically prepared and inspected in the workshop, and painted with a first layer of lead-based anti-corrosion paint. Once the Tower has been riveted together and assembled, two new coats of paint are applied, colored with Venetian red. After the blue of the drawings, this tint was an aesthetic display of both the anti-corrosion necessary for the conservation of the metal as well as the engineer's work. The survey carried out during the 20th painting campaign identified these initial red layers. It confirmed the exceptional three-tone gradation from base to top described by Gustave Eiffel. His total mastery of the processes involved in iron construction enabled him to go beyond the engineer's point of view and create an aesthetic work of art. By coloring the Tower, Eiffel became part of a history of architecture in the 19th century that was imposing color as a means of writing, following on from the work of Paxton and Owen Jones on the Crystal Palace in 1851. The Eiffel Tower in red embodies the new architecture of the 19th century.

5. Colors of the Architecture Reproduced and Broadcast

5.1 The Yellow-Brown Tower

Gustave Eiffel undertook the first repainting campaign in 1893, and established a regular schedule of one campaign every seven years. This new protocol involved a new color scheme. Gustave Eiffel abandoned Venetian red and chose ochre pigments in an oil-based binder. For the 1900 Universal Exhibition, Gustave Eiffel publishes "The 300m Tower". The collection of technical drawings from the design office reflected the ochre hue of the iron. The color was henceforth known as the "Yellow-Brown". The process of painting the Tower intersected with the history of anti-corrosion painting techniques and the invention of protocols adapted to the new steel structures. From 1907 onwards, Gustave Eiffel used "Ferrubron" for the regular repainting campaigns of the puddled iron. The Eiffel Tower, built for the Universal Exhibition, was to be dismantled twenty years later. Gustave Eiffel gradually obtained permission to maintain the Tower. The 1907 color was faithfully reproduced until his death in 1923 and maintained until 1965. The Eiffel Tower was red for three years, forming an image that has become mythical for artists.

6. Color of the Urban and Landscape Context

6.1 The Brown Tower

In 1965, the Eiffel Tower was listed a Historic Monument. A new color was chosen, a grey-brown that would express the iron of the Tower. The blue hue was considered; it was not the forgotten memory of the technical designs of the 19th century; it was a request to erase the Tower from the Parisian sky. The attempt to paint the Tower blue in a way that breaks with Gustave Eiffel's choices is a paradox. Monumental

architecture that dominates the Parisian landscape, anticipates the heritage rediscovery of this architectural century.

7. Modified Color of the Architecture, before the Color of the Restored Architecture

7.1 The Work in Progress

The 20th repainting campaign respects the goals of the anti-corrosion treatment. A new analysis of the history of the Tower's colors has guided the choice of the new tint: it respects Gustave Eiffel's choice of a "Yellow-Brown" oil paint graded into three tones. Eiffel invented a red Tower for the Universal Exhibition, then the ochre hue of the stone of the Parisian monuments.

Color was constantly reinterpreted to express the changing values of architecture (Figs. 2 and 3).

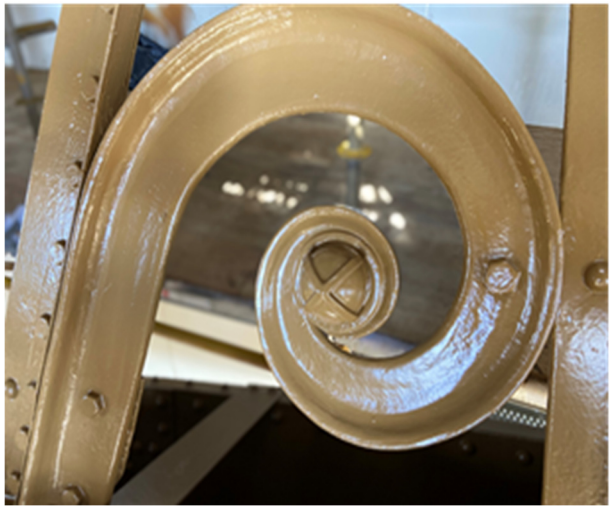

Fig. 2 Eiffel Tower, detail on pickled framework.

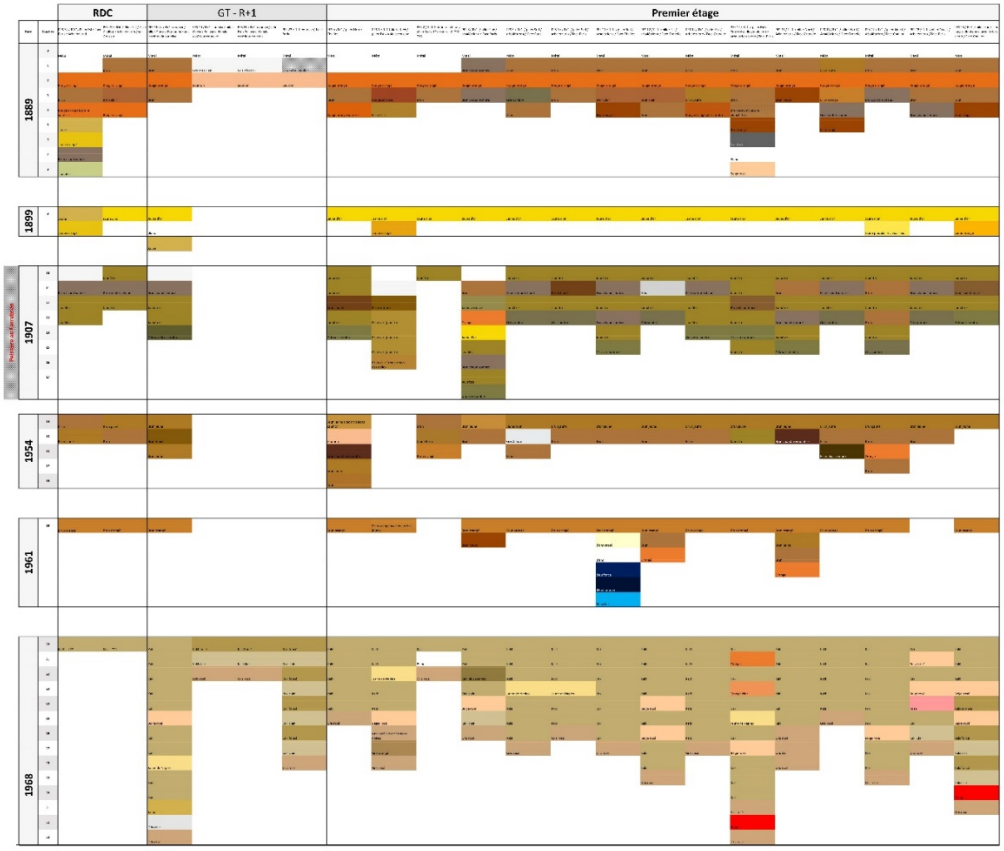

Fig. 3 Summary table of the stratigraphic surveys, PAG Agency with Claire Dandrel and Annick Texier, LRM.

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[1] The Eiffel Tower is the property of the City of Paris and its management is untrusted to SETE. The main Contractor for the 20th repainting campaign is Agence Pierre-Antoine Gatier, represented by Marion Gauchard, architecte, project director.

Journal of Civil Engineering and Architecture 17 (2023) 542-544
doi: 10.17265/1934-7359/2023.11.004

From Winckelmann to Restoration of the Colors: Modern Architecture from Kodachrome to B&W

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Abstract: The restoration of modern architecture raises open issues starting from the interpretation of its original colors. The essay investigates the different approaches emerged by restoration works that have led to erroneous restitution of the building's image.

Key words: 20th century architecture, restoration, color, photography.

1. Introduction

"Restaurer un édifice, ce n'est pas l'entretenir, le réparer ou le refaire, c'est le rétablir dans un état complet qui peut n'avoir jamais existé à un moment donné". Unchanging, unforgettable, incisive, incipit of the entry *Restauration* [1] written by Eugène Emmanuel Viollet-le-Duc is still capable to explain, better than any subsequent theories in the field of architectural restoration, the ways in which the restoration of existing buildings, no matter how old, was conceived, but more importantly, was realized.

2. From Kodachrome to B&W

Architects involved in restoration works usually have the goal of restoring the buildings "dans un état complet qui peut n'avoir jamais existé à un moment donné". However, respecting only the visual integrity of Modern heritage does not require testing, nor analysis, nor checks. That state of completeness lies in our retinas, even before the countless stock images (actually, always the same) that usually accompanied the inauguration of modern buildings that were manifestos of a new way of living, even before new places to live.

Those photographs were made in black & white: color photography, made available on the market since 1936 by Kodak company with the introduction of Kodachrome film, would not become commonplace until after World War II (although the architectural photographers would often continue to use black & white, considered more elegant, less distracting in relation to the qualities of volumes, of the shadows, of the surfaces of buildings whose main value laid in the purity of the surfaces, the absence of ornamentation, the sculptural volumes; all qualities for which the chromatisms of Kodachrome and later color films represented an unnecessary distracting factor).

The fate of modern architectures was thus, inevitably, to be restored to a state of renovated completeness, we are now certain, that buildings had never had.

But what are the reasons for the "return" to black & (especially) white (Fig. 1)? When was it decided that modern buildings should be white, somewhat like cathedrals, almost a retaliation to what Le Corbusier [2] stated in one of his famous books?

We do not have a certain data, nor a precise author or event; the answer may lie in what has been written above, in the image that books, journals and magazines have created over decades, in the absence of color in those photos, republished countless times. But there is also a possible critical thinking that moves away from the European context and, through the Cornell University

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Fig. 1 Le Corbusier, Pierre Jeanneret, Doppelhaus, Weissenhofsiedlung, Stuttgart (Germany) (restoration works: 2003-2005).

Fig. 2 R. Meier, Arp Museum Rolandseck, Remagen (Germany), 2004-2007.

and New York, returns to Europe, contributing to the creation of the myth of White Architecture. The proposed interpretation is probably affected by those who, like us, were trained in the last quarter of 20th century with the myth of the Five Architects and their white architecture.

Richard Meier[1] [3] claimed to have trained through the Alberto Sartoris's book entitled *Gli elementi dell'architettura funzionale: sintesi panoramica dell'architettura moderna*, published in Milan in 1932 by the publisher Hoepli. The volume contained many photographs, obviously in black and white. That is why the idea of the whiteness of rationalist architecture would find a new legitimacy through the reflections of Meier, Eisenmann, Gwathmey, Graves and Hejduk, reflections destined to have good fortune not only in the design of new buildings[2] (Fig. 2) but, in a kind of mirror game, in the restoration of modern heritage.

The reference to Sartoris also introduces the question of the classical inspiration in the choice of the white color for modern architectures, when they were really white and there is no doubt that there were some: "It is particularly the Italian Rationalism that pursued this idea of the Classic, an issue in relation to which there is a wide critical thinking" [4].

The classic and the white immediately refer back to the initiator of that misunderstanding, to him who had wrongly interpreted the white color as the only hue of classical sculpture and architecture: Johann Joachim Winckelmann. Just under three centuries after the theories of the German historian we know that his assumptions about the whiteness of the sculptures and buildings of Classicism, were completely wrong; and

[1] On Richard Meier and the use of white color in architecture, cf. Zammerini, M. 2016.

[2] The fortune of the white color in contemporary architecture is vast: from Sverre Fehn to Santiago Calatrava, from Steven Holl to Kenzo Tange, there are many examples of architectures in which the pervasive choice of white is a decisive factor in building of their image.

we know that such an idea not only led to the glories of Neoclassicism, but also led to the removal of many colored fragments that resisted and were preserved on ancient statues and temples.

Our hope is that, long before what happened in Winckelmann's case, it will be accepted today that modern buildings were much less monochromatic than the images in which they are captured, as evidenced by numerous studies carried out on the different layers of plaster and paintings present on their surfaces[3] [5]. If we are not yet culturally ready to choose the "simple" material conservation, let us then at least refer to the category of scientific restoration dear to Gustavo Giovannoni, trying to return to the color palettes that distinguished modern buildings at the time of their inauguration.

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[3] One of the most pioneering studies on the subject was that of Le Corbusier's Doppelhaus in Weissenhof; beyond the result, on which opinions differ, it is necessary to note that the attention to the analysis didn't set an example for many subsequent interventions, where the will for renewal prevailed.

Journal of Civil Engineering and Architecture 17 (2023) 545-547
doi: 10.17265/1934-7359/2023.11.005

A New Chromatic Vision: The Early Impact of Color Photography on the Representation of Architecture

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Abstract: The role of color photography in the representation of architecture is a subject little investigated by architectural historiography. The link between the color values of architectural design and its visual transmission in the early phase of modernism was certainly problematic. Color photography had an undeniable impact on architectural color in practice: color photographs in books and periodicals published between the 1940s and 1960s clearly influenced the use of color in architectural design.

Key words: 20th century architecture, color, photography, historiography.

1. Introduction

On 28 April 1952, a crowded audience attended a lecture at the RIBA by the American architectural critic, educator, and photographer George Everard Kidder Smith (1913-1997), who surprised them with a superb selection of color transparencies of Italian architecture. The *Architectural Review* editor James Maude Richards (1907-1992) wrote afterwards: "If only one had colored photographs like Mr. Kidder Smith's readily available, and technical resources to reproduce them, architectural publications could be very much livelier and do a more worthwhile job in bringing architecture on the printed page than is possible at the moment" [1]. This anecdote makes us rethink the role of color photography in the representation of architecture, a subject that has remained under-investigated in architectural historiography.

Kidder Smith had a very strong interest in capturing the buildings he visited and wrote about recording them on black and white film or color transparencies (Fig. 1). He believed that architecture seen in color pictures would finally give a new strength to the perception of space on lifestyle magazines, even if most photographers continued regarding it with suspicion.

Edwin Smith (1912-1971) resented the loss of creative control that stemmed from the fact that few photographers had the facilities to process their own color material [2]. Jan Versnel (1924-2007) thought that color photography interfered from the photographer's primary task of delineating architectural features.

2. The Chromatic Values of Architectural Design and Its Visual Transmission

Attempts to develop color photography had been undertaken since the invention of the medium, but it was only with the introduction of the Kodachrome transparency film in 1935, followed by Kodacolor negative stock in 1942, that a major breakthrough was achieved. Although these processes later became mainstream in architectural photography, there has been no clear account of its origins in practice. We know that John Maltby (1910-1980) in UK experimented with color and that the *Architectural Review* essayed its first major attempt at color printing in it feature on the new BBC (British Broadcasting Corporation) building in London in 1932. One of the first projects by American architectural photographer Ezra Stoller (1915-2004) was a set of color pictures to be taken during New York's World Fair, which were published in *Architectural Forum* in 1939.

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Fig. 1 Self-portrait in color of G.E. Kidder Smith (lower left) and his wife Dorothea (upper middle with a raised arm), Temple of Juppiter, Baalbek, Lebanon, 1950. © Archivio Progetti, Università Iuav di Venezia.

The connection between the chromatic values of architectural design and its visual transmission in the early phase of modernism was certainly problematic. Color photography had an undeniable impact on architectural color in practice: color photographs in books and periodicals published between the 1940s and 1960s clearly influenced the use of color in architectural design. Le Corbusier's *Villa Savoye* was almost exactly as monochrome as the many black and white photographs taken of it. This kind of imagery was spawning an architecture deficient in chromatic values.

But some architects, such as Gio Ponti (1891-1979), and photographers, like Giorgio Casali (1913-1995), went beyond the established monochromatic representation of their buildings, and in their pictures and articles for *Domus Magazine* considered color in a new way. Ponti was enthusiast when *Domus* No. 312 (November 1955), dropped few lines regarding his happiness in publishing in architectural color photographed images. The images he refers to were elevations of Swedish houses in Gutenberg, placing the emphasis on chromaticism in architecture so that even in Italy, where various vernacular buildings are traditionally painted or plastered with lively colors, we move from deliberately melancholic grey buildings to a colorful new architecture, "because—as Ponti states—you have to make beautiful houses, beautiful neighborhoods, and lively happy colorful cities" [3].

Exactly a year before, Ettore Sottsass (1917-2007) published in *Domus* No. 299 an article titled "Structure and Color" concerning the role in design, using the chromatic issue in order to construct a critical approach towards a culture of design considered no longer suitable to provide answers to the social and cultural transformations taking place. Sottsass became known for his asymmetric forms and, perhaps most of all, his flamboyant use of color, often in bold, clashing combinations. "You don't save your soul just painting everything in white," he once wrote. "Color can arise and be in harmony with the imperatives of structure, without destroying it." In the same article, Sottsass notes how the expressiveness of architecture had been entrusted, up to that moment, exclusively to the shape and structure: "By dint of whitening the walls, by dint of lightening and wanting light we have almost lost the meaning of the colors in Architecture" [4]. And quoting the painter Theo van Doesburg (1883-1931) it allows him to reiterate his opposition and to affirm not only that the color must regain its expressive function but also "reach the maximum emotional intensity beyond, far beyond the structural reality" [4].

The factual representation of architectural color had in fact long been desired by architects in professional practice. Many architects travelled with two cameras: one for shooting in black and white, and another to record colored architectural surfaces and interiors. One of these was Bruno Morassutti (1920-2008), who spent a long period at Taliesin West looking deeply at Frank

Llloyd Wright's color schemes. Morrassutti's visual legacy is only one of the many examples of color photography informing an understanding of architectural color in its historical contexts [5]. Konrad Gatz and Wilhelm O. Wallenfang's book *Color in Architecture: A Guide to Exterior Design* (1960), is a significant volume that makes the point of how color photography interpreted and transmitted architectural color[1] [6-8]. Translated into several languages, it has never been considered as a photo-book where the medium expressed the increasingly polychromatic nature of contemporary architecture.

3. Conclusions

The visual representation of architecture in color was more than an analytical tool; it had an important role in the historical development of our general knowledge and provided information on the character of modern architecture, helping to define a more rounded approach to architectural design.

The identity of a building becomes clear in an architect's choices of how material, texture, sheen, and color come together. Gatz and Wallenfang's photographs predate and challenge the now-standard notions of architectural visual identity that have been formed by more recent and candy-colored photography. Traditionally, photography has always commodified buildings, transforming the newly built houses and their facades into objects of desire. Yet fitty years before their repurposing as a pastel fantasy, the city's modern buildings were pictured as optimistic symbols of urban life. These photographs depict the city as a humanist artefact of the modern world and deliver a more accurate understanding of the intentions of their creators. Today, they provide valuable information toward preservation efforts, elucidating, not only the details of the architectural physical appearance, but the poignant drama of the city's ambition as well.

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Journal of Civil Engineering and Architecture 17 (2023) 548-556
doi: 10.17265/1934-7359/2023.11.006

The Rediscovery of Polychromy in Some Le Corbusier's Works: A Problem of Restitution

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Abstract: The theme of the restoration and conservation of polychrome surfaces will be addressed through several recent case studies of interventions on Le Corbusier's work owned by the Fondation Le Corbusier: the Petite Villa sur Le Lac Léman (1923-1924), the Maisons La Roche and Jeanneret (1923-1925), and his apartment-studio in the Immeuble Molitor (1931-1934). The recent interventions allowed for numerous preliminary studies (*in situ*, archival, and laboratory), and proved to be an opportunity for historical and material knowledge, paying close attention to discoveries and observations during the construction phase. An important aspect of these experiences was the in-depth study of polychromes, conducted on architectural surfaces but also on furniture and fixed furnishings made of concrete, metal and wood. This was an important moment in the knowledge of the work during the restoration phase because of the richness of the stratigraphic surveys related to the many modifications made over time sometimes by Le Corbusier himself. This text exposes technical, scientific, and operational aspects specific to the study of interior and exterior polychromes, and in parallel raises theoretical-methodological questions of restoration of the polychromies and the painting.

Key words: Le Corbusier's polychromies, world heritage, modern heritage preservation.

1. Introduction

The Fondation Le Corbusier, universal legatee of the architect, custodian of all his archives and owner of three of his architectural works, holds the moral and patrimonial rights of the architectural, literary, artistic and plastic works of Le Corbusier. Therefore, any intervention on the architectural work anywhere in the world, should be authorized by the Fondation, whether or not the work is protected as an historic monument.

Many of Le Corbusier's works have been restored, in the last years, including projects under the control of the Fondation Le Corbusier, as the La Roche and Jeanneret houses, between 2008 and 2015, which underwent restitution of the interior's polychromies and of the original colored plaster on the facades.

Some of these projects have contributed to renewing the methods of approach to restoration to more understand the authenticity, integrity, and history of the buildings. Each restoration campaign is also the opportunity to enrich the material understanding of the work, its genesis, and the processes involved, thanks to the research undertaken, and the materials uncovered.

This is particularly true for the knowledge of polychromies in Le Corbusier's work.

1.1 The Le Corbusier's Polychromies

Color is a constant theme in Le Corbusier's work, both as an artist and an architect. From his earliest texts (articles in Esprit Nouveau, Almanach, etc.), color in architecture seems to have a clear function, which is at the same time necessary, repeating the truth already recalled by Fernand Léger: "Man needs color to live, it is an element as necessary as water and fire" [1].

In his fundamental text on this subject (1931), "Polychromie architecturale, étude faite par un architecte (mêlé, d'ailleurs, à l'aventure de la peinture contemporaine) pour des architects" [1], which was to

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[1] Archives Fondation Le Corbusier, Paris.

accompany the presentation of the *Salubra* 1 Keyboards, the role of color is clearly defined by Le Corbusier: "color acts on a psychophysiological level, producing sensations that are specific to it, sometimes even unrelated to the concrete fact of the architectural spaces in which we find ourselves; color can provide a 'lyrical escape' from the constraints of reality. […] attached to sensations of 'order and sentimental wellbeing'; color masks form, alters volume 'allowing you to appreciate from a volume only what you wish to show'" [2].

To work with Le Corbusier's architectural polychromy in today's restoration projects, it is essential to understand the architect's intentions.

Among the authors who have analyzed the theme of color in architecture through Le Corbusier's texts, we should mention historian Luisa Martina Colli in the early 1980s, who traces the path from Le Corbusier's youth, through the articles in L'Esprit Nouveau with Amédée Ozenfant, to the development of the three Gammes du purisme in the *Salubra* Color Keyboards. In the 1987 Encyclopédie, she wrote: "on this tool for organizing architectural color, which is in any case one of Le Corbusier's most sensitive and beautiful ideas" [2]. This author had already stressed the importance of other texts in addition to the 1931 text, and of conferences such as Le Corbusier's 1936 speech at the Congresso Volta in Rome, notably on the role of mural painting in architecture.

Other authors who have dealt with this subject include Arthur Ruegg, who has worked extensively on the 1910s and the Purist period, on the use of color from artist to architect: "it was obviously a transfer of the painter Jeanneret's experiments to the practice of the architect Le Corbusier" [3]. He also deserves credit, as an architect and restorer, for having understood the value of republishing the *Salubra* Color Keyboards with Le Corbusier's 1931 text, stressing first and foremost the importance of "matter". Indeed, he explains that: "Le Corbusier, for example, often demanded very smooth, matt paints. Before the war, these were powdered pigments bound with glue or oil, and painted with a brush […] today's synthetic paints give quite different results, the only advantage being their resistance to wear" [3].

The problem of documentation and iconography is fundamental to the question of color when it comes to restoration projects. Indeed, we have images in black and white at least up to the end of the 1950s. As Gérard Monnier pointed out at the Fondation Le Corbusier's Rencontres on the theme of Color in 1982[2] in the text "la couleur absente": "[…] contemporary 'colored' sources are lacking. Long after the end of the Second World War, architectural photography was still not represented in color in books and magazines (particularly in Europe and France). So we have to make do with a deficit in the representation of color in buildings". Another of Monnier's observations is that "until the 1960s, color work in LC buildings was absent and ignored" [4].

All these elements certainly also contributed—but that is another subject—to transmitting an image of Le Corbusier's architecture, and modern architecture in general, as white architecture (Fig. 1).

In all the works on architectural polychromies, focused on its theoretical reflection, it seems to us that

Fig. 1 Maisons La Roche et Jeanneret, Paris XVI, 1926 © FLC.

[2] The IVth Rencontres de la Fondation Le Corbusier was held in Paris in 1982.

the question of interior polychromy is limited to paint, in particular to tint (red, blue, green...), without taking into account its materiality, its composition, which can modify its perception and effect in space. For interiors, other surfaces beyond walls, such as "cream", black or ochre porcelain stoneware flooring, dark havana or green marbled linoleum or pink or grey rubber; right down to the color of curtains and furniture.

Information on *Salubra* (1931-1959) is also necessary to understand Le Corbusier's projects. *Salubra* wallpapers are "oil paints sold in rolls" for interiors. They are color charts, the first of which, from 1931, derives from purist ranges, notably the Grande Gamme, made up of natural pigments: earths, ochres, ultramarines ...). These color keyboards were designed to facilitate the construction phase, the painting of interiors, in an industrialized approach, to apply the desired color evenly and without error: "To the architect who is always more or less at the mercy of a painter's mishap, *Salubra* offers great peace of mind, ensuring, with a proportion of oil and color that is always right, a constant quality of tone and material" [5], just as one chooses a door handle or porcelain stoneware tiles from a catalog. It is worth remembering that, in those days, painting was done on site: the painter prepared the mixture to obtain the desired shade, and mistakes were easy to make.

But what is even more interesting than the color charts and shades themselves is the combinations Le Corbusier proposes between these colors, presented in "ambiances". As Martina Luisa Colli explains, "the collection comes with special masks that make it possible to isolate in detail two or three colors (for frames, chairs, rugs, etc.) by relating them to the basic colors of the walls, ceiling or floor" [2].

Reference publications often claim that there are no examples of *Salubra* wallpaper still in place. However, at the time of the restoration works, we found several walls still covered, notably in the architect's most intimate buildings: the Petite Villa and, above all, in Le Corbusier's apartment-studio (Fig. 2).

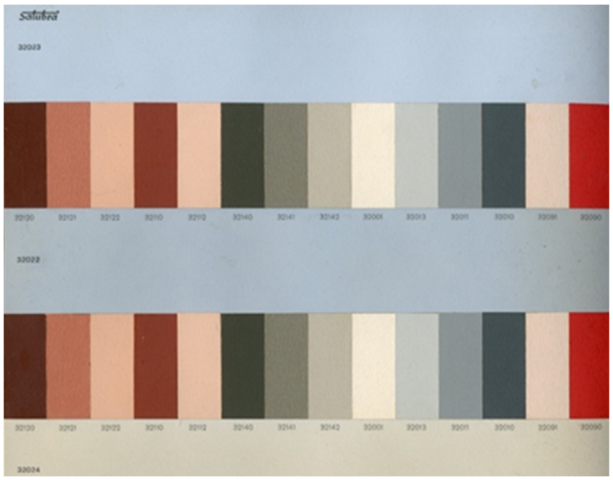

Fig. 2 Les claviers de couleurs, *Salubra* © FLC.

For all these reasons, the question of architectural polychromy remains, in our opinion, entirely open. This is apparent in every restoration project, with questions raised about materials, supports, pigments and binders, ageing, and about implementation, whether or not there has been any preparation, modifications, repainting or restoration, and so on. Indeed, the difficulty of studying the polychromes of Le Corbusier interiors and their transformations, through texts and archival documents (letters, estimates, invoices, company memoirs, annotations on sketches, etc.), black and white photos and possible *in situ* remains, has prompted us to present some of the discoveries made in the field, to answer questions, cross-reference information and formulate questions.

2. Method and Materials

The Fondation Le Corbusier is fortunate in its role, and as part of the creation of the archives of the restauration of Le Corbusier's architectural work, to participate in numerous projects, and to follow studies and construction sites, important moments in the knowledge of the work built.

Preliminary studies are an important and necessary phase in any restoration project. For each project, we are confronted with Le Corbusier's writings on polychromy, with archival and iconographic documents, and then with the site and the work itself. We have to take into

account the specificity of each architectural object, and each restoration project must be carefully examined.

Today, polychrome surveys are carried out almost systematically—it has become "normal"—before any work is carried out, often supplemented by specialized laboratory analyses.

These studies must be carried out before the choice of project, the objective (to return to an original state or another reference state, or to do nothing), and for documentary reasons. The context of a restoration project is a time for study and questioning, and the ideal moment to try and find new documents (color photos/diapositives, publications, testimonials, etc.), confirmations and new information on the polychromy of the work. These studies, carried out by specialists, are important beyond the scope of the planned project, since the aim is not to systematically return to the "original" polychromies or other reference condition. The aim is to understand, document and provide new elements of understanding for future research.

The presentation of some examples of restoration work on sites owned by the Fondation Le Corbusier may illustrate these questions and attempt to provide some starting points for reflection.

2.1 The Maisons La Roche and Jeanneret

The interior polychromies of the Maison La Roche are certainly the best-known and most studied. Indeed, in his 1931 text entitled "Polychromie architecturale, étude faite par un architecte (mêlé, d'ailleurs, à l'aventure de la peinture contemporaine) pour des architects" [1], Le Corbusier presents two cases together: the Maison La Roche in Paris, for its interior polychromy, and the Cité Frugès in Pessac, for the polychromy of its facades[3].

Begun in 2008 with the work on the interiors of Maison La Roche, and completed in 2015 with work on the façades and garden of Maisons La Roche and Jeanneret, the restoration work on the buildings housing the Fondation Le Corbusier was the outcome of a process involving intense research and experimentation and intended to be exemplary[4] [6]. It contributed to renewing techniques used in previous decades for the preservation of Le Corbusier's built work. The aim was to systematize and combine historical and archival research, core drilling and other types of material analyses, technical studies, to confront data acquired with historical accounts, and to create scientific committee to monitor work in progress.

We know from the texts that for the first time Le Corbusier implemented an architectural polychromy based on purist theories at the Maison La Roche in 1925, before the creation of his *Salubra* color keyboards. In *L'oeuvre Complète* published in 1929, Le Corbusier explains: "Inside, the first polychromatic experiments, based on the specific reactions of colors, allow for 'architectural camouflage', i.e., the affirmation of certain volumes or, on the contrary, their concealment. The interior of the house must be white, but for this white to be appreciable, a well-adjusted polychromy must be present: walls in half-light will be blue, those in full light will be red; we make a body of the building disappear by painting it in pure natural umber, and so on"[5]. In the archives, we have two important documents. The specifications for the "painting lot", in which it is described: "Kitchen, W.C., toilet, pantry, cloakroom, radiators: recoating and two coats of oil; on all joinery (wood and iron), recoating, priming and two coats of oil. In the rest of the building, sanding and two coats of glue"[6]. And an invoice from Célio from March 1925, at the end of the works, with "the list of colors used for the composition of the tones of glue and oil-based paints on Rue du Docteur Blanche in Auteuil [...]: yellow ochre, red ochre, ivory black, natural Sienna, burnt Sienna;

[3] About the case of Cité Frugès in Pessac, in this same publication: Paola Scaramuzza, *Le Corbusier and Pierre Jeanneret's Cité Frugès: The Polychromy Issues.*

[4] Study and work on the interiors between 2008-2015, by Pierre-Antoine Gatier chief architect des Monuments historiques and Ariel Bertrand, wall painting restorer.

[5] Le Corbusier. 1964, op.cit., p. 60.

[6] FLC 5-1-176, Archives de la FLC, Paris.


ENTREPRISE GÉNÉRALE DE PEINTURE

VITRERIE

PAPIERS PEINTS

MÊME MAISON

A. Célio

218, Rue Saint-Jacques

Fig. 3 Archive's document of the painter, Celio, 1925.

natural umber, burnt umber, English green, ultramarine blue, charcoal blue, chrome yellow"[7] (Fig. 3).

As part of the pre-restoration study carried out in 2008 by the agency of Pierre-Antoine Gatier, chief architect of historic monuments in charge of restoring the houses, restorer Ariel Bertrand carried out a polychrome recognition campaign (stratigraphy, sampling of the pictorial layer and laboratory analysis) of the entire building (wall, ceiling, skirting boards, joinery, built-in furniture), in order to recover the shades and materials used. The reference layer chosen for the restoration was the original one, from the time of delivery in 1925. This work, combined with the analysis of archival documents such as period publications and old photographs, confirmed the use of the binders cited in the archival documents from the outset. Oil paint was used for metal (radiators, doors, window frames), wood (furniture, window frames), cement (shelves, window sills) and humid rooms (kitchen, pantry and bathrooms). Glue paint was used for certain pigments (such as sienna or ultramarine), while oil emulsions (a mixture of oil paint and water, which dries more quickly) were used for other rooms.

This type of application was found in all buildings of the period, from the Purist period onwards.

During the restoration project, a color chart was created for the interiors, based on La Roche's specific palette for maintenance work.

Important information about the Maison mitoyenne Jeanneret, the home of Albert Jeanneret, the architect's brother, and his wife Lotti Raaf, comes from a letter discovered in the living archives of the Fondation Le Corbusier. The letter was written by the former owner to the President of the Foundation in December 1970, following her visit to Paris for the inauguration of the Foundation. She writes about the colors restored during this first major restoration of the two houses. She vividly recalls her memories of the original colors: "The back wall of the salon was all white, as was the neighboring wall on the left, while the one on the right was pale green as you had it painted. The pink color was used only on the back wall on the left as you enter, as well as on the area around the large window. The tone of this pink you chose is not very good, it should be, not darker, but less yellow, more pinkish. The door to the kitchen was blue in the same tone as the other areas (…) The radiators were steel gray everywhere, as were the two garage doors. Terrace: skirting boards and shelves in a fairly deep blue-grey, fireplace in green-grey (…)"[8].

This document gave us a better understanding of the polychrome surveys and the knowledge required for the restoration. For example, we were able to confirm that the radiators were painted dark grey, rather than the same color as the wall, to differentiate them as an element of comfort, a sign of modernity, but also for more technical reasons. This arrangement can also be seen in the photographs of the period, although in black and white something that had not been noticeable during the first restoration campaigns.

The correspondence also highlights the role played by Lotti Raaf, who seems to have played an important

[7] FLC H-1-3-2, Archives de la FLC, Paris.

[8] Letter of Lotti Raaf to Gimonet, president of the FLC, 7 December 1970, Archives vivantes de la FLC, Paris.

role in the choice of colors for her house. But this document also confirms the surveys carried out on the exterior facades, some years later the restoration work of the Maison La Roche's interiors, and reveals the original state of the coatings, as Le Corbusier had intended. Lotti Raff wrote to Gimonet: "As for the exterior of the two houses, I find it deplorable that they were painted, especially in white. Le Corbusier had applied a cement coating mixed with powdered cut stone, resulting in a 'slightly' rough surface with a very attractive yellowish sand color. (…), who told you that the houses have always been white, has forgotten what they were like in the beginning (…) would it be feasible to scrape it off and see for yourself? That would be n° 10, which has never been painted, only repainted"[9]. Surveys carried out by restorer Ariel Bertrand on the coating on the facades confirmed all the information given in Lotti Raaf's letter.

Rediscovering the polychromies of the interiors and the "stone colored" facades (Le Corbusier's expression) was a surprise to specialists and novices alike, reared on images of the famous "white villas" of the Modern Movement (Fig. 4).

As regards to the exteriors, the same principles presided over the choice of colors and materials when restoring the interiors as closely as possible to the originals. Restoration of Maison La Roche helped to underline the pertinence and plastic qualities of the original architectural polychromies and to emphasize the role of color in the design and perception of the different spaces. It thus seemed logical to echo these interior spaces in the outward surfaces. Maisons La Roche and Jeanneret thus found again their original 1925 façades.

Fig. 4 Stratigraphic survey on the facade of the Maison La Roche: in layer 1 the original plaster (Cimentaline).

2.2 The Petite Villa Sur le Lac Leman

The polychromies used for his parents' second house in Corseaux, is rarely mentioned in texts, yet it is still partly in place and present in archives and family correspondence.

The project and the work carried out since 2011, based on Elise Koering's historical study, first revealed a very pale green façade [10] [7]. We know from correspondence that Le Corbusier wanted a green-tinted lime (then "oiled") and that the company, convinced of its fragility, proposed a silicate paint. This arrangement still exists under the metal claddings of 1931 and 1951, whereas oil paints were used on the other facade elements (Fig. 5).

What is interesting to note for the interiors is that the first paint campaign was practically never called into question, apart from one proposal in 1951 which seems not to have been carried out, not being present in the *in situ* stratigraphic studies. Over time, the original shades were "evoked" by colors that were close to each other, but produced with different materials and applications, modifying the perception of color and space. During the most recent repainting of the interiors, carried out as part of the house's centenary celebrations, the shades were recaptured according to the original materials, based on polychrome surveys carried out on site: glue paint, oil paint and emulsion. During this last campaign of work, it was possible to observe the installation of the wallpapers as described in the archive documents. In a letter from Le Corbusier, precise instructions were

[9] Letter of Lotti Raaf to Gimonet, president of the FLC, 7 December 1970, Archives vivantes de la FLC, Paris.

[10] Historical studies: Elise Koering; Jean-François Dedominici painting; Fanny Pillet, restorer.

Fig. 5 Stratigraphic survey and essay of painting for the façade of the Petite Villa, 2012 © FLC.

given for horizontal wallpaper hanging, which was found here and, in his apartment-studio, notably in the servant's bedroom.

2.3 The Painting of His Personal Apartment-Studio in Paris

Indeed, one of the surprises of the restoration work on Le Corbusier's apartment-studio in the Immeuble Molitor is the discovery of *Salubra* wallpapers, not only those whose existence was known from the texts, but systematically, for example under the wooden plywood added in 1939 to the ceilings and walls. This was the first layer, the first campaign of "painting" that Le Corbusier had in mind, when he moved into his new apartment in 1934, a few years after *Salubra* had been marketed. The apartment subsequently underwent several painting campaigns, some of which were of Le Corbusier's own design, identified with the help of mural restorer Marie-Odile Hubert. We can summarize: a 1934 state, mainly wallpaper that disappeared under the wood panelling in 1939, with a partial repainting, of which Le Corbusier testified to his mother: "The painters left. We've rearranged and it's fine! It's going very well and now my apartment looks finished. The problem was the blackness due to the soot from Boulogne: the ceiling was all covered in black, and the walls in pale green. I installed natural oak paneling on the ceiling. Ditto on the green wall. Ditto on the elevator shaft. The previously gray wall where the little fireplace used to be is now a slightly stunned vermilion red. The dining room has been repainted white (walls and vault)"[11]. A 1948-1950 state, with more vivid color changes, for example in the bedroom, the last state before the architect's death (Fig. 6).

Subsequent renovations were identified by the FLC's living archives and *in situ* surveys, the first of which dates back to 1969.

For the apartment, the Foundation wished to restore the interior polychromy of 1965, the last known state desired by the architect. Indeed, the state of the interior masonry made it impossible to preserve the historic paintings. So, once the layers had been identified, they were characterized using laboratory analysis to obtain the most precise possible knowledge of the paints used

Fig. 6 Bathroom, with the discovered blue of the apartment-studio of Le Corbusier, 2018 ©FLC.

[11] Letter by Le Corbusier to his mother, 8 April, 1939. Le Corbusier-Correspondance-tome 1-Lettres à la famille 1900-1925, In-folio, 2011.

to restore them. The identification of pigments and binders enabled oil emulsions to be remade for the entire apartment-atelier[12].

We therefore felt it necessary to preserve most of the stratigraphic surveys carried out by Marie-Odile Hubert *in situ*, after the restoration work, in order to leave a trace of this work, to understand the stratifications over time, and to enable us to reconsider a choice of shade [8-13].

3. Conclusion

As far as the Purist period is concerned, we now know—thanks also to academic work[13] confirmed by these latest restoration projects and the studies carried out in connection with them—that none of Le Corbusier's Purist works were originally "white", despite the major references also by Le Corbusier. "Left totally white, the house would just be a pot of cream" [14]. Facades seem to have changed color from the late 1960s, after the architect's death, with the first major restoration campaigns. The very first was the Villa Savoye and the gardener's lodge, whose restoration started in 1967 by architect Jean Dubuisson (1914-2011), but shortly followed by the La Roche and Jeanneret houses in 1970 by the Fondation Le Corbusier.

The latest restorations, based on increasingly comprehensive historical and scientific studies, have also made it possible to rediscover the interior polychromes. This knowledge of the architect's wishes seems to have resulted in a choice to restore the original polychromes. This applies not only to the colors, but also to paint materials and application. For this reason, it is important to preserve the stratigraphic surveys, to conserve superimposed layers and the history of color changes, with an educational objective that also allows us to revisit the choices made in the restoration work.

[12] Studies and restoration (2014-2018) by François Chatillon, Architect; Marie-Odile Huber, restorer, JF Dedominici, painting.

[13] For example, the work of Anna Rosellini for the grant of the FLC on "Théorie et construction de la surface Puriste", 2005.

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Journal of Civil Engineering and Architecture 17 (2023) 557-563
doi: 10.17265/1934-7359/2023.11.007

Le Corbusier and Pierre Jeanneret's Cité Frugès: The Polychromy Issues

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Abstract: From 1924 to1926, with the Cité Frugès in Pessac, Le Corbusier and Pierre Jeanneret realized an urban area as a laboratory where research on architecture polychromy was achieved among others. Colored facade was applied as a tool to modify urban space. This neighbourhood has always been inhabited and transformed by its inhabitants over time. In the 90's, studies for the global image protection of the neighbourhood included polychromy research conducted to restore the shades of origin. However, the colors have often been interpreted in various ways. Nowadays, besides the shade problems, other challenges have arisen linked to the preservation of the facade materials. This paper presents the recent archive research done to clarify the shade references and lay the groundwork so as to choose the right material to use and further research in the future.

Key words: Le Corbusier, Cité Frugès, polychromy, architecture.

1. Introduction

The Cité Frugès, a housing project in Pessac in southwestern France, was an experiment of sorts, something entirely new, commissioned by Henry Frugès who allowed Le Corbusier to set up his theories.

In 1924-1926, with the so called "Quartiers Modernes Frugès" Le Corbusier and Pierre Jeanneret realized an urban area where each element was drawn in detail [1]. This is among the first research conducted by Le Corbusier on the modes of house grouping, the construction of a standardized housing, therefore cheap, and the implementation of facade polychromies. With standardization, industrialization and taylorized mass production were among the basic principles of the project. Combining a modular system six house types were created: the Quinconces, Zig Zag, Gratte-ciel, Arcades, Jumelles and Isoléés. In this project Le Corbusier achieved a coherent and orderly landscape [2].

This neighbourhood has always been inhabited and will continue to be so, which is crucial to assure not only its life but also its authenticity. It is well-known that it has been transformed by its inhabitants over time [3].

The Cité Frugès was included in the UNESCO (United Nations Educational, Scientific, and Cultural Organization) World Heritage List in July 2016, among the 17 works by Le Corbusier that make up the series "The Architectural Work of Le Corbusier: An Exceptional Contribution to the Modern Movement" [4]. The history of its protection started in the '80 and went through various stages.

Since 1998 the ZPPAUP (Zones de Protection du Patrimoine Architectural Urbain et Paysager) regulation has especially provided constructive rules and advice on how to protect and develop housing[1]. It concerned the external appearance of the structures and therefore polychromy [5].

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[1] ZPPAUP (Zone de Protection du Patrimoine Architectural, Urbain et Paysager), provision of a law whose purpose was to ensure the protection of the landscape and urban heritage and to highlight neighbourhoods and sites to be protected for reasons of an aesthetic or historical nature ("500 m perimeter" around a historic monument) by replacing it with a "smart perimeter". In 2010, the ZPPAUP was replaced by the AVAP (Aires de mise en valeur de l'architecture et du patrimoine).

Nowadays some of the contents of this regulation deserve to be re-examined in the light of the new protection measures as historic monuments, new knowledge, and the inhabitants' new expectations.

Restoration, repair, and maintenance projects (past or in development), confront with the current practices of the restoration of 20th century architecture and the essential issues of ecological transition and sustainable preservation of the environment.

This article presents the most recent archival research on the topic of polychromies, cross-referencing data with *in situ* surveys, which has helped to highlight several aspects and lay the foundations for deeper future research.

Besides, not only should we focus on the conservation issues but also on the demands of use and contemporary living respecting the French "Monument Historique" heritage[2].

1.1 The Le Corbusier "Architectural Polychromies"

"Il se dégage des constructions de Pessac une esthétique inattendue, neuve. Nous avons aussi appliqué une conception entièrement neuve de la polychromie, poursuivant un but nettement architectural modeler l'espace grâce à la physique même de la couleur, affirmer certaines masses du lotissement, en faire fuir certaines autres, en un mot composer avec la couleur comme nous l'avions fait avec les formes. C'était ainsi conduire l'architecture dans l'urbanisme"[3].

In Le Corbusier's words color is used as a tool to modify space. A psychological component of the perception of space is also present in his reflection.

The essential theme of the function of color in architecture, indeed in the entire urban space, is present in the letter sent to Le Corbusier by Piero Bottoni on December 12, 1927, with "annexes" photographs of watercolors entitled "Cromatismi Architettonici" [6].

In the response to Bottoni in 1928 Le Corbusier explained the architectural polychromy in the case of the Cité Frugès, saying that when fifty or a hundred houses created between them a space that was like an exterior room, whose walls were formed from the facades of various houses, the same problem was happening. Instead of accepting the white uniformity of all the houses, one could feel obliged to call on the color to modify these spaces (*Chambre exterieures*) so as to continue, thanks to the color, the effects of the order and therefore create larger spaces and clearly set the composition intentions.

He affirms that at Cité Frugès the external polychromy, treated with precise rigor, has come to constitute a prodigiously eloquent contribution to modern architecture. The list of colours mentioned by LC for Pessac includes: Terre de Sienne brulée pure, Bleu pale, Blanc, Vert pale, Rose, Terre d'ombre pure, Noire[4] [7].

Over time, decay but also inhabitants' modifications made the external polychromy no longer recognizable in most cases [8].

The studies in the 1990s for the definition of the preservation document ZPPAUP, were a great opportunity to research the hues of polychromy[5].

However, the references taken, and the recommendations of this document, are also reinterrogated today according to the choice of the material of the tinting as well as the presence of decay and cracks.

The recent architectural and landscape study commissioned by the Municipality of Pessac was an

[2] "Monument Historique": this status recognises the heritage interest of a property. The protection implies a shared responsibility between the owners and the national community with regard to its preservation.

[3] "The buildings in Pessac exude an unexpected, new aesthetic. We also applied an entirely new concept of polychromy, pursuing a distinctly architectural goal: to shape space through the very physics of color, to assert certain masses of the housing development, while making others vanish, in a word, to compose with color as we had done with shape. It was a way of bringing architecture into urban planning". (translated by author). Le Corbusier, brochure and presentation at the inauguration of the Quartiers Modernes Frugès, on the occasion of the official visit of M. de Monzie, Minister of Public Works in Pessac on June 13, 1926, FLC H1-20-36-001/4.

[4] Le Corbusier letter to Piero Bottoni, January 15, 1928, in Jenger, J. (2002).

[5] ZPPAUP Ville de Pessac Accessed September 14, 2023. https://urly.it/3y6bg; https://urly.it/3y6bp; https://urly.it/3y6bj.

opportunity to reexamine archive documents in order to specify first of all the semantic definition of the tints, the materials and search for the principles of composition.

2. Cité Frugès Polychromy's Archival Research, Method and Materials

The historical research was based primarily on the corpus of archives of the Le Corbusier Foundation composed by the documents and letters between the architects and Henri Frugès and the operators on site[6].

Three drawn plans describing façade polychromy are also well-known, as well as the color perspective published in the "L'Architecture Vivante" in fall 1927 [9] (Fig. 1). However, these documents do not give a complete and detailed view of the polychromy composition. Not all house façades are depicted.

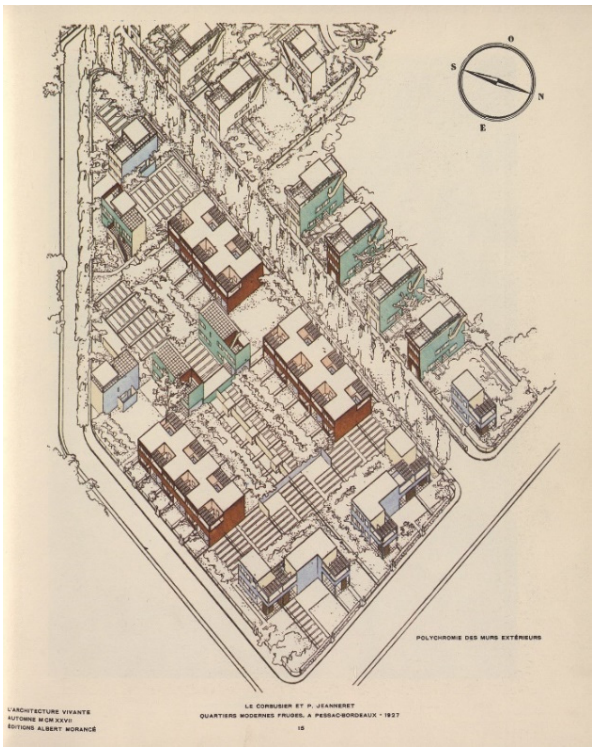

Fig. 1 Cité Frugès, Polychromie des murs extérieurs in L'Architecture Vivante , Automne & Hiver 1927.

In order to understand the theme of polychromy in this period of Le Corbusier's oeuvre, a number of other slightly earlier projects belonging to the same client and geographical context were analysed.

The archives relating to the *Maison Tonkin*, the experimental house realized just before, contain a list and a description of the precisely planned polychromy. An estimate of the house of paintings "Lefranc", now "Lefranc Bourgeois" is present (*FLC H1-19-328*)[7].

In March 1925, on the site of Lège, his first small housing development, Le Corbusier asked for photographs of the site to determine the polychromy of the facades (*FLC H1-20-31*)[8].

The construction site photos of Pessac allow us to distinguish differences in shades on the facades and several details. For example, the shade of the entrance caps (a light or "Sienna earth" color as the wall) or the wall baseboard (darker than the wall). However, black and white images are still difficult to interpret, a closer look at the archives can give us more solid information.

2.1 Polychromy's Chronology through Archival Documents

On August 6, 1925, the first exchanges on the prices of the paintings include the treatment of the shutters, a quote of the painter Gintrac: mention of linseed oil on natural wood (shutter) and price for oil paint in two/three layers, "peinture à la colle" (glue-based paint), without location accuracy. The quote also mentions wallpaper laying (*FLC H1-19-75*).

On August 19, 1925, the painter Courbu, offers an estimate of "peinture à l'huile" (oil-based paint) three layers on wood or iron with preparatory work, cleaning and filler paint, three layers of baseboard paint, layer paint on interior plasters, price differences between smooth or speckled plaster (*FLC H1-19-331*).

[6] The main documentary sources are listed here: Archives FLC H1-17; H1-18; H1-19; H1-20; Archives FLC photographies d'époque, L2-15; Archives FLC "ensemble des plans des Quartier Modernes Frugès"; Archives Municipal Ville de Pessac-Bordeaux Métropole; Pessac 3Fi, 13W; T1; Archive DRAC Nouvelle Aquitaine: Quartiers modernes Frugès.

[7] Letter from Le Corbusier to Henri Frugès, experimental house built on the factory site

[8] Le Corbusier asked Frugès for photographs "that would make it possible to see how the pavilions looked in space and consequently to determine the polychromy of the façade" (trans. by the author).

In November 1925 Henri Frugès wrote to Le Corbusier telling him they had fired the painter, refused his work as the paint was already peeling, it was too thick and uneven: "in a word, it was bad work". Since half of the palette that Le Corbusier had made was missing because the painter had left with it, Frugès asked Le Corbusier to send his own back to him (*FLC H1-19-331*).

The painter Courbu was replaced by Gintrac, a photo showing "Peinture G. Gintrac" sign is present in the archive (*FLC L2(15)29*). In November, the first group had almost finished, Frugès made an urgent request for wallpaper and colour kitchen tiles (red or red & white) and he was waiting for the furniture (*FLC H1-19-330*).

On December 2, 1925 the painter asked through Frugès which tones the other groups should have, in particular number 32, 33, 30 (the "*Gratte-ciel*" house type), and the whole line of his double two-storey houses (*Quinconce* house type), because he was going to start soon, as soon as he could. A chromatography plan for all possible houses was also requested (*FLC H1-19-255-001*).

On December 10, 1925, Frugès wrote to Le Corbusier: the painter asked about the tone of the woodwork of the 1st floor for 6 houses, and if he wanted skirting stairs or not. Should the ramp be passed to the minium? For the outside facade: what is the tone of the porches? Is it a white underside and bands of burnt shade? Is there color stump fireplace on the terrace leading to the pergola? Are the exterior baseboards painted? Which color? (*FLC H1-19-241-004*).

Unfortunately, we could not find a response letter.

In March 1926, HF told Le Corbusier that "It is important that you also see the effect of the new *terre de Sienne brûlée* (burnt sienna colours) on buildings 61 to 66." (*FLC H1-19-259-001*).

It is interesting to note that on April 28, 1926, in preparation for the inauguration, LC indicated that the priority was for the facades to be painted (*FLC H1-20-3-004*).

In the article published in 1926 in "Mon chez moi" the author visits the neighbourhood and spoke about color images she refers to "brown, white or light green" houses [10].

Through the letter of July 21, 1927 we learn that they were very undecided about the type of paint to use for the final coats, because the provisional coat that had been applied for Monzie's visit, on an insufficient silicate base, had flaked all over, and the prices quoted for the complete restoration, the stripping, the first coat of pure silicate, then at least two coats of oil paint, made Frugès hesitate a little (*FLC H1-19-339*). On house No. 37 (the one destroyed during an allied bombing raid in the World War II) they used an oil paint containing 50% petrol, and the effect seemed good to Frugès; but he wondered if they could do without oil by applying two or three coats of silicate. Even if he knew that Le Corbusier was not in favour of implementing the latter process because of the streaks that rain makes. In any case it was urgent to know, or else definitively commit to the expense represented by oil paint, which would still have to be repainted every two or three years (*FLC H1-19-339*).

This reflection is noteworthy regarding the choice of materials and the issue of maintenance already present in this moment.

In September 1927 Mrs. Motorny, the painter's wife present on site, wrote to LC saying that work was in progress. This allows us to know that "three red groups, two green houses, and a blue house were completed. The first layer on seven *Gratte-ciel* as well as a red *Arcades* house was done. She asked Le Corbusier about the white color, because if it is pure white, it will not keep its freshness and within three weeks it will turn yellow. The painter should blend a small quantity of ultramarine or Prussian blue which will stabilize the white color or use a slightly creamy white"[9] (*FLC H1-19-340*). Le Corbusier answered proposing to add vermillion or Prussian blue as he did not like the creamy white (*FLC H1-19-341*). In the middle of

[9] Translated by author.

November 1927, Mrs. Motorny wrote that the work was almost finished (*FLC H1-19-342*).

Jumping in 1931, Mr. Gabriel, a lawyer, and Union President for the Defence of the Neighbourhood, asked if Le Corbusier could give some advice to make the neighbourhood more pleasant, he wanted some advice concerning maintenance as some inhabitants had begun to make some refurbishing.

Le Cobusiers visited the Cité Frugès in May and was really aggravated by the situation noting that some colors had been changed. He wrote to Mr. Vrinat, engineer, Frugé's employees who later inhabited the neighbourhood, saying that it was unacceptable to have allowed the *Quinconce* to be painted in the glycine color (June 16) (*FLC H1-20-120*). Mr. Gabriel answered on June 11, asking for a model to advise people on the proper shades to use (*FLC H1-20-119*). LC replied on June 16 "we had the useful drawings prepared for the colors of the houses" (*FLC H1-17-239*). Le Corbusier said that Mr. Gabriel had a large painted plan and side sheets and 8 exact color samples (N° 1, 12, 23, 42, 91, 112, 120, 130), and pure base colors "without mixing anything else but white". The letter mentioned the eight colors: 1 = blanc, 12 = noir + blanc, 23 = outremer+ blanc, 42 = vert anglais + blanc, 91 = rouge vermillon + blanc, (un vermillon solide de commerce), 112 = rouge anglais + blanc, 120 = terre sienne brulée, 130 = terre d'ombre brulée (*FLC H1-19-345*). This plan and this palette have never been found.

2.2 Polychromy since ZPPAUP

In the 90's, the ZPPAUP regulations addressed the issue of the overall image of the city, which means restoring the public space, the streets, and their visual boundaries. The ZPPAUP study also analysed the theme of polychromy in depth. In addition to the study of the archives, numerous color tests were carried out in order to define a reference shade palette[10] (Fig. 2).

This document introduced in the palette the "terre de Sienne Claire" (light Sienna color, translated by the author), a color that was not found in the Cité Frugès archival documents but that refers to the "*Salubra* color keyboards" [11, 12]. The work with the Swiss wallpaper manufacturer *Salubra* was, however, a research that Le Corbusier developed after, in the 30's, and was probably based precisely on the experiences of the Pessac construction site[11]. The only reference for the wallpaper in Pessac project is the brand *Maison HEIBEL peinture* in Paris, 29 rue Bonaparte (*FLC H1-19-334; H1-19-335, H1-19-336*). Le Corbusier himself wrote that "*Salubra* is 'oil paint sold in rolls'. Instead of applying three coats of colour to walls and ceilings in a site full of workers, this paint is now applied by a machine, at the last minute. *Salubra* paint must be applied to a healthy, durable substrate, this product is both flexible and resistant, with fine colours whose purity have been previously tested by chemists. It is colourfast and washable. For architects who are always more or less at the mercy of a painter's mistakes, *Salubra* paint offers great peace of mind, ensuring a constant quality of tone and texture with the right proportion of oil and colour" [13].

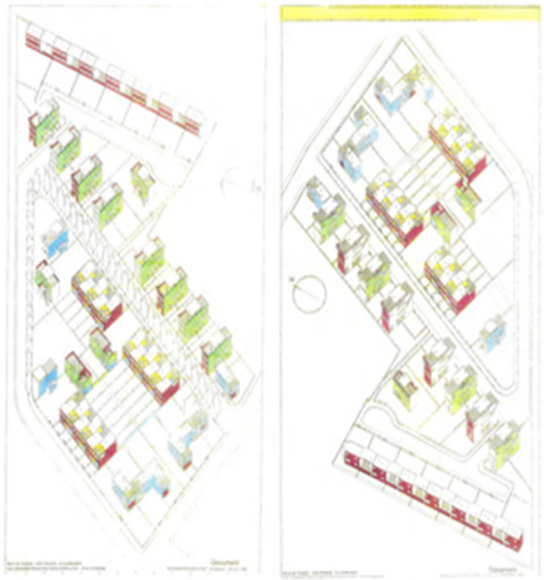

Fig. 2 Study on exterior polychromy as published in the ZPPAUP graphic document, document 30-31, 1998.

[10] ZPPAUP Ville de Pessac Accessed September 14, 2023. https://urly.it/3y6bg; https://urly.it/3y6bp; https://urly.it/3y6bj.

[11] Le Corbusier designed two color collections for a Swiss wallpaper manufacturer *Salubra* brand in 1931 and in 1959.

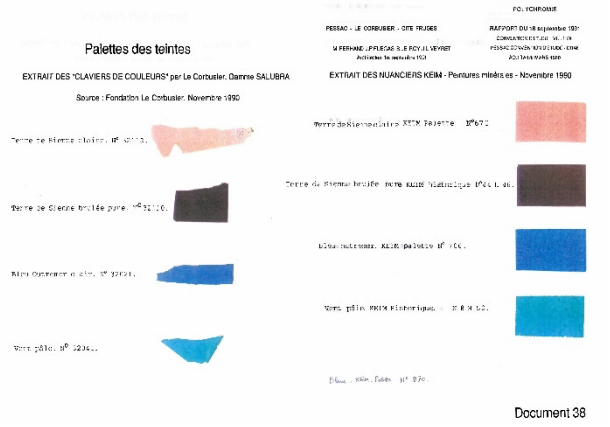

Fig. 3 Color palette: on the left the Salubra range, on the right the transposition in Keim paints, source: ZPPAUP document 38, 1998.

Therefore, the colour palette that emerged after the ZPPAUP studies was willfully both based on archive research and on the *Salubra* range. It stated that "In the interests of authenticity and respect for this very delicate issue, and after examining the available archive documents, it was decided to refer on the one hand to the colour palette described by Le Corbusier on 11 July 1931 in a letter addressed to Mr. Gabriel, the site manager; and on the other hand to the corresponding *Salubra* range of colours, bearing in mind that they were published for Le Corbusier a few years after the Pessac experience"[12]. The shades in this palette are: *Le Blanc-Le Noir-Le Terre de Sienne Claire-Le Terre de Sienne brulée pure-Le Terre d'Ombre brulée-Le Bleu outremer clair-Le Vert pâle*.[13]

Thanks to the ZPPAUP research, tests and studies, these tones have found equivalents in the *Keim* range of mineral paints (Fig. 3). However, these tints were not always respected and the choice of using mineral paints on surfaces with dynamic cracks is now questioned.

3. Results and Discussions

Since the last in-depth archive search, three phases of painting have been identified during the construction and early life of the district. The first was in late April-June 1926 for the inauguration with Mr. de Monzie (*FLC H1-20-03*). The second phase took place in September-November 1927, during Mrs. Motorny's letter, when the state of many of the houses was revealed (*FLC H1-19-340*). Finally, the third phase took place in July 1931 when the drawings and the palette of 8 colours were sent from Le Corbusier to Mr Gabriel (*FLC H1-19-345*). These three phases show us the challenges not only in the definition of colours, but also in the type of paint to be used, the choice of materials, number of paint layers, colour effects and maintenance issues. An "identical" restoration already poses a major problem in terms of interpreting the paintwork of origin.

Today, compared to the time when the ZPPAUP study took place, many issues relating to the reconfiguration of the overall image of the district can be considered achieved. The formal qualities of these architectures, which were previously falsified to the point of being unrecognisable in some cases—such as their massing, façades and polychromy—are now recognised, protected and even sought after by residents, who are asking for clarification so that they can intervene to conserve and sometimes restore them.

However, new issues and challenges arise nowadays. The deterioration of materials, and in particular of certain plasters and concrete parts, is becoming increasingly evident (Fig. 4).

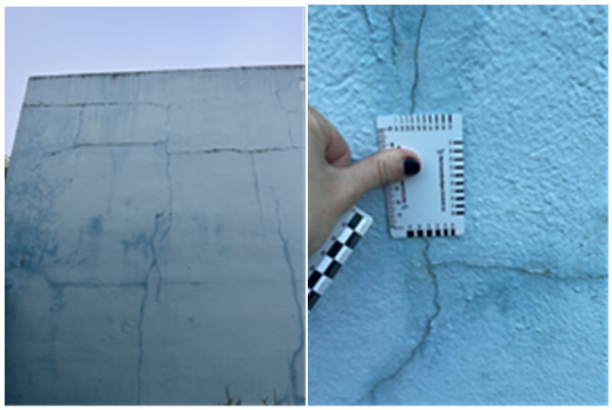

Fig. 4 Example of the current state of a Cité Frugès house's polychromy and its analysis.

[12] ZPPAUP Zone P1 article 8, commentary 8.4.

[13] ZPPAUP Ville de Pessac Accessed September 14, 2023. https://urly.it/3y6bg; https://urly.it/3y6bp; https://urly.it/3y6bj.

Fig. 5 Examples of sampling points for polychromy analysis.

4. Conclusions

Studies of architectural polychromy in Le Corbusier's work have progressed in recent years. The historical approach to documents, including the building as a document, as well as the question of authenticity, now leads us to consider chronology more carefully. The "colour keyboards" in the Salubra range, as is also shown in the ZPPAUP, were invented by Le Corbusier after the Cité Frugès project. The latter may have led Le Corbusier to seek out "colour in rolls" in order to avoid the ups and downs of the building site. The role of the Pessac experience in the architect's career is now being examined in greater depth, and is increasingly revealing itself to be the cradle of certain research, notably on polycromy, which will be developed in the years to come.

Today, research into the palette used for the Pessac project is going on. The next step is to identify the samples to be analysed during the *in situ* surveys carried out on the basis of this archive research (Fig. 5).

Acknowledgments

This in-depth study of the polychromy archive of the Cité Frugès was part of the architectural and landscape study launched by the City of Pessac and carried out between 2021 and 2022 by the author for A-BIME company.

Special thanks go to the Fondation Le Corbusier for sharing their archives and knowledge.

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Journal of Civil Engineering and Architecture 17 (2023) 564-573
doi: 10.17265/1934-7359/2023.11.008

Color as Material: Ceramic Surfaces in the Work of Gio Ponti in Milan (1927-1970)

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Abstract: The study is based on the analysis of the design and operational path conducted by the architect Gio Ponti on ceramic materials between the late 1920s and the early 1970s, with particular attention to applications in the Milanese context. Milan represents the main laboratory for experimenting with the figurative, plastic and chromatic potential of modern ceramic surfaces. The analysis of archival documentation preserved at the CSAC Archive in Parma, the Gio Ponti Archives in Milan and the Archivio Progetti at the Iuav University of Venice allows for a deeper understanding of the design path at different scales, from the design of specific lines of ceramics for industry, to their application in buildings. The second part of the analysis is aimed at tracing the conservation problems of ceramic surfaces, with the aim of highlighting both the cultural and technical aspects that are affecting the conservation of this heritage. Connected to the latter aspect is a focus on the principal deterioration phenomena of modern ceramic surfaces related to different types of substrates, providing in-depth knowledge that opens up new strategies for their conservation.

Key words: Ceramic surfaces, modern architecture, Gio Ponti, Milan, deterioration patterns.

"(CERAMIC) is a marvelous material
it is an incorruptible material
let's wrap architecture in mosaic tile,
even buildings have a skin.
Let's clad architecture in diamond tip elements:
they do not simulate a built wall, like a parapet,
but announce how they are a finish:
they bring to surfaces a plastic value
and play with light under the movement
of the sun: they are beautiful" [1].

1. Introduction

Exploring Gio Ponti's relationship with ceramics requires first retracing, through his writings and rich existing archives, the confluences between architecture, art and industry beginning in the late 1920s. From his earliest works, Ponti assigned ceramics a crucial role in expressing modern architecture. While simplifying surfaces (a lack of projections, of eaves, of decorations, etc.), the new language of building saw these finishes as a tool capable of creating dynamic and three-dimensional surfaces [2]. Likewise, the role of light became fundamental to the perception of ceramic façades: "finishes acquire (and bring to architecture) new values—plastic values—under the sky, under nighttime light, shimmering and changing their appearance with the passing of shadows (to which we must add color, which has infinite possibilities in ceramics)" [3].

The study analyzes Gio Ponti's design and operational path with ceramics between the late 1920s and early 1970s [4-7], with a particular focus on his work in the Milanese context. Indeed, Milan has been the principal laboratory for experimenting with designs and building solutions linked to the plastic and chromatic potentialities of ceramic surfaces.

The analysis of the archival documentation conserved at the CSAC archive in Parma, the Gio Ponti Archives in Milan, and the Archivio Progetti at the Università Iuav di Venezia, permitted a further exploration of the design work linked in many cases to the definition of individual tiles, and how they were to be applied.

The second part of the essay looks at issues of

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conserving the ceramic surfaces designed by Gio Ponti, with the aim of understanding the technical aspects and cultural considerations that effect the conservation of this heritage. This latter topic is tied to a focus on the principal deterioration phenomena of modern ceramic surfaces, also in relation to the diverse typologies of support, with the aim of expanding knowledge that opens up new scenarios for conservation.

2. Method and Materials

2.1 Ceramic Surfaces: Industry and Architecture

The use of ceramic materials in the 20th century architecture is documented in industry publications and manuals that focused a great deal of attention on these surfaces, with important contributions such as that of Enrico Agostino Griffini from 1931. A commonly known text in both academic and professional settings, *La costruzione razionale della casa* was a fortunate publication reprinted various times between 1931 and 1950. In particular, the 1932 edition [8-10], featuring a section dedicated to *New Materials*, contains an exploration dedicated to stoneware, with a focus on how it is made and its particular characteristics. This material is produced by baking "at a temperature of 1300°C, a mixture composed of clay, feldspars and colored pigments, previously passed under a hydraulic press. This produces a product with a crystalline structure, in other words vitrified, that possesses the typical qualities of clay: compactness and homogeneity as well as impermeability, non-porosity, solidity, inalterability and the aesthetic quality of grain and color. Slabs of stoneware are fabricated in the form of tiles and small mosaic tiles. The surface of these tiles, the side visible after installation, can be matt or enameled. [...] Matt stoneware (unglazed porcelain, Ed.) is available in a vast variety of colors. The glaze applied to the surface considerably increases its decorative value. Glazes can be flamed, poured and crystalized; there are lively and brilliant decorations, as well as more matt and velvety finishes" [8]. Characteristics of durability, resistance and hygiene are central to the description of this material: "Stoneware is impermeable and without porosity, [...] which makes it impenetrable to humidity, impurities, microbial vegetation and allows it to be suggested for all those applications where issues of hygiene are of particular importance. What is more, stoneware also presents notable qualities of resistance and inalterability that makes it durable, not subject to wear, not susceptible to cutting and deteriorations that, possible in other materials, create receptacles for dust and putrid and fermentable elements" [8].

Among the materials available in the construction market at the start of the 1930s, special mention must be made on:

- red clay body ceramics (lithoceramics), obtained by firing a single iron-rich clay;
- unglazed porcelain tiles (grès) obtained from a mixture of plastic clays of kaolinitic nature, feldspars (develop glassy phase) and quartz sand skeleton;
- glazed porcelain tiles, obtained from a mixture of low-plastic, kaolinite-rich clays with added quartz sands and feldspars. The glazed variation helps cover natural pores and provides brightness and chromatic variations;
- clinker, obtained from a mixture of fine clays fired at high temperatures (>1,250 °C) by introducing the principle of vitrification.

As noted by Fulvio Irace, the use of ceramics as a material of modern architecture can be considered "a natural development within the reform movement in the field of decorative arts that, since the end of the 19th century, established [...] the theme of aesthetic variation in serial products" [11].

In a country that had not yet experienced the industrial boom linked to the employment of this material in construction, Gio Ponti was one of the first architects, together with Angiolo Mazzoni and Giuseppe Pagano, to regularly choose ceramic finishes as early as the late 1920s. According to Ponti, this choice is also related to the issues of early deterioration evident in modern plaster

finishes, to which new "incorruptible materials"[1] [1] should have been preferred, particularly for the façades subject to prolong exposure to weathering and pollution.

2.2 Rigor and Neutrality: The 1920s and 1930s

In addition to being one of the privileged materials during his lengthy and fortunate professional activity, ceramics also represented for Gio Ponti the beginnings of his career. The interest in the artistic and decorative aspects of this material saw him designing ceramic tiles for the Richard-Ginori company in Sesto Fiorentino, where he served as artistic director of production from 1923 to 1933.

Ceramic mosaic tiles were above all one of the principal tools for expressing the "never-exhausted creativity" [12] that Ponti dedicated to his native city. For the architect, Milan was the embodiment of the evolution of ideas, technique and form connected with this so small yet so highly characterizing element of industrial production. Oscillating between design, architecture and the decorative arts, Ponti turned, case-by-case, to unique forms as part of what remained an always recognizable language.

In the Borletti House (1927-1928), designed with Emilio Lancia, ceramics was selected to bring character to the walls of a sizable stairwell, where large sage-colored tiles dialogue with stair treads in light colored stone. In the Adele House (1934), one of the ten *Domus* or *Typical Houses* completed between 1931 and 1936, this material became, instead, a qualifying element in the design of façades. The basement finished in grey stone tiles is flanked by clinker that, as in the coeval Rasini Tower (1932-1935), defines the external surfaces.

Likewise, in public and corporate buildings completed during this period, Ponti employed ceramic with a style that expresses a sober modernity, characterized by simple lines. In the Montecatini 1 building (1936) and the EIAR building, later the RAI (1939), unglazed porcelain tiles are once again utilized as an internal finish in areas of intense traffic, such as stairs and lift blocks (Fig. 1).

Ceramic tiles in tones of grey and beige are tested in unique combinations with aluminum and its alloys, and with traditional materials such as marble and wood, to create sober and light polychromies.

2.3 Eclecticism and Play: Second Half of 20th Century

During the post-war period Gio Ponti definitively asserted himself as the most enthusiastic supporter of ceramic materials considered "so ancient and modern at the same time" [11]. In Ponti's work, ceramics became from an anonymous, serial surface to a small design object that overcame the standard and the monotony of repetition, amplifying and qualifying the relationship between architecture and the city.

Fig. 1 Studio Ponti Fornaroli Soncini with E. Bertolaia, EIAR building, later RAI building (1939), unglazed porcelain tiles in combination with stone and wood (2021).

[1] The adjective "incorruptible" referring to ceramics appears as early as 1957 in his volume, Ponti, G. (1957).

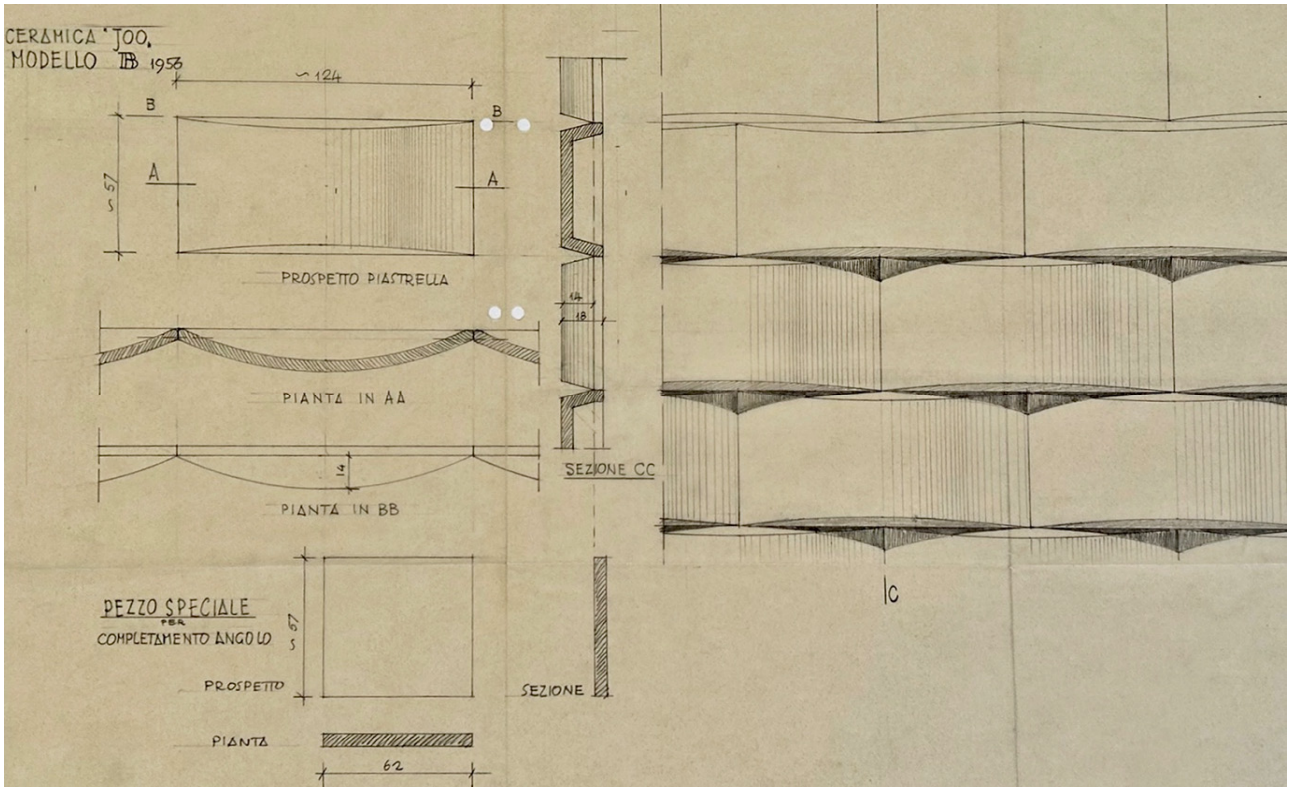

Fig. 2 Studio Ponti Fornaroli Rosselli, Ceramica Joo, model B, 27th April 1956 (part.). © CSAC Centro Studi e Archivio della Comunicazione, Università degli Studi di Parma, Fondo Gio Ponti.

During the 1950s, thanks to the experimentation conducted abroad which led to the construction of the Villa Planchart (1954) and Arreaza (1956) in Caracas, and the Villa Namazee in Teheran (1957-1964), Ponti intensified the use of ceramics supported by fruitful collaborations with companies that worked with him to develop new products for modern architecture (Fig. 2). The use of ceramics to qualify façades represents for the architect a tool that participates in the definition of the "landscape generation of architecture", recognizing this material's ability to guarantee the quality of public space: "The Architect, the Artist, must paint. Because, in the end, he must compose a landscape also with his walls: always, natural or urban as the case may be, the architect creates a town. This comes from the appearance (of the elevation) and dimensions and its walls or surfaces: this is the reason for their color: this is the reason for their reliefs (that the architect must know how to measure, and thus must possess in his fingers, for the play of the sun and light; something tactile). (This is the landscape generation of architecture)" [1].

In 1957, the attention to ceramics as a cladding for buildings produced at the industrial scale, was already expressed in his book *Amate l'architettura*, returned in the article "Un rivestimento per l'architettura" [3] published in *Domus* magazine, under Ponti's direction at the time. The essay is dedicated to the production of the Ceramiche Joo company in Pioltello Limito (Milan) designed by Ponti. The eclectic language of this ingenious alchemist of plastic forms was exalted by the fortunate collaboration with this company initiated in 1956, which led to the creation of a rich series of glazed porcelain tiles with relief surfaces whose patents are conserved by the Archivio Centrale dello Stato (Rome). The photographs taken by Giorgio Casali[2] accompanying the article exalt the theme of surfaces in relief and polychrome finishes

[2] Iuav Archivio Progetti, Fondo Giorgio Casali, IUAV/AP, Casali 1.fot/3/228, s. 596, n. 059992.

resulting from combinations of different forms and colors: the new tiles called “diamonds”, “embrace”, “ashlar” and “pebble” mark the passage from the flat surface of the classical mosaic tile (2×2 cm) to a vibrant finish capable of giving “lightness and grace to volumes, and reflections of light and sky” [3].

The analysis of the documentation conserved by the archive CSAC Centro Studi and Archivio della Comunicazione at the University of Parma allows reconstructing in detail the outcomes of the architect’s intensive contacts with the ceramic industry during this period. The date 27th April 1956 can be found on the drawings of models “B”, “C” and “D” of the Ceramiche Joo: each element is drawn in plan, elevation and section with a detail of 1:1 scale[3], and a particular attention to the possibility to compose the diverse elements and the creation of special pieces.

While not involving his work in Milan, there was also an important collaboration with D’Agostino Ceramiche, a family-run business in Brignano (Salerno) active from the 1930s. The collection designed by Ponti between 1960 and 1964 for the Hotel Parco dei Principi in Sorrento would mark an important step for the company toward a renewed image of modernity. The tiles, measuring 20×20 cm and 9 mm in thickness, were decorated by hand in variations of white and blue, differing from those of the same dimensions for the *Multipref 729* series created by Ponti for Gabbianelli company in the 1950s, decorated using the technique of silk-screening.

The two-toned combination of white and blue can also be found in the 1961 drawings for Ceramiche Mazzotti S.A.C.I.E in Turin. Each drawing describes the geometric, chromatic and decorative characteristics and the numerous possibilities for their composition[4] (Fig. 3).

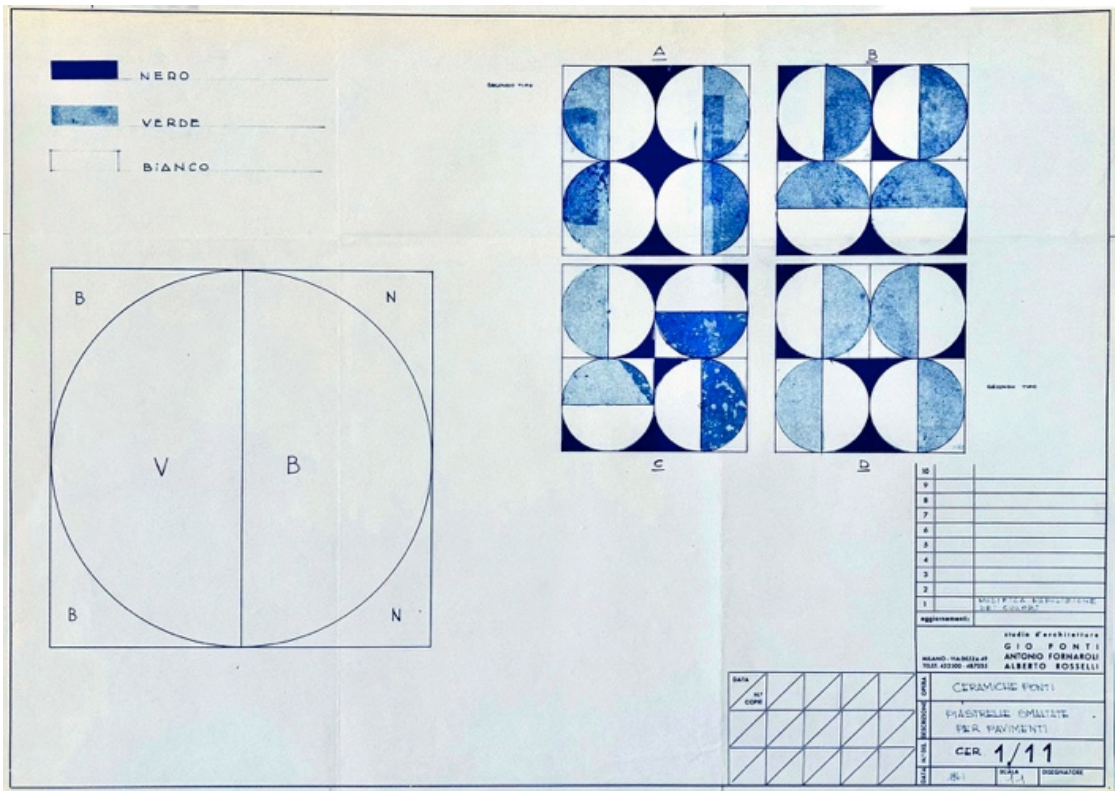

Fig. 3 Studio Ponti Fornaroli Rosselli, Ceramiche Mazzotti, glazed ceramics for floors, 1961 © CSAC Centro Studi e Archivio della Comunicazione, Università degli Studi di Parma, Fondo Gio Ponti.

[3] Centro Studi e Archivio della Comunicazione (CSAC), Fondo Gio Ponti, Ceramiche Joo, 1956, coll. 339/2, inv. PRA 526, id. 13990.

[4] CSAC, Fondo Gio Ponti, Ceramiche Mazzotti S.A.C.I.E. Torino, 1961, coll. 326/6, inv. PRA 724, id. 14393.

The modular composition of different elements was also explored in 1965 for Gabbianelli, a Milanese company for whom Ponti developed the project *Nine Infinite Designs* [13] (reduced to seven, in 1966): the decoration of the tiles is based on variations of blue, yellow and white, allowing for the composition of numerous variations of designs and color: "it is false that industrial production signifies monotony and the mortification of fantasy. When we place our trust in the imagination of artists and «designers», of ingenious architects, modern industrial production offers infinite choices" [5, 13].

The second post-war period and the city of Milan have represented for Ponti a privileged context for experimenting with the new expressive possibilities of ceramic surfaces. Indeed, this material became an almost constant presence in his work through the 1970s, proving its ability to adapt to widely differing contexts, from residential buildings (RAS Houses in via Monti, 1956; House in via Vallazze, 1956; Melandri House, external base, 1957; INA building in via San Paolo, 1963-1967), to scholastic architecture (the *Trifoglio* and School of Architecture at the Politecnico di Milano, 1956), to corporate architecture (Second Montecatini building, 1947-1951; Edison building, 1952; Pirelli tower, 1956; Assolombarda building (stairs), 1958; Palazzo RAS, 1962-1963; Banca del Monte, 1964; Montedoria building, 1970; Savoia Assicurazioni building, 1971) to religious architecture (St. Luca Evangelista, 1955-1961; St. Francis of Assisi at Fopponino, 1961-1964; St. Carlo Hospital Chapel, 1964-1969).

This latter field presents a particularly rich documentation dedicated to the construction of the votive temple of St. Francis of Assisi "offered by Milanese business owners" (1961-1964) whose design spanned 15 years[5]. In particular, the drawings dated 30th May 1961 show the attention by Ponti to the detailing of the surfaces of the façade, in a combination of "scraped grey cement" for the base and "white-grey" Piccinelli ceramic mosaics, alternating with "white-silver diamond ceramic" and oak portals[6]. Inside the building was instead planned the use of "flat Joo ceramic in the same color as the façade"[7]. The most relevant drawing from this series is certainly the detail of the installation of the finishes, shown on the drawing *Façade detail. Parish residence facing the church square*, 28th April 1961, scale 1:20[8]. It represents a very detailed drawing which shows, in elevation and section, the methods of installing the 'diamond' ceramic tiles respectively on structures in reinforced concrete and on block infill with a 2 cm layer of cement mortar (Fig. 4).

Similarly, for the façades of the San Carlo Hospital Chapel (1964-1969) Ponti also selected Joo ceramic, both diamond tip and flat, in grey enamel, in assonance with the other buildings of the hospital. The tiles are 5×10 cm in size, alternated with bands made of glass blocks by Fidenza company and diamond tip windows in smoked glass. The drawing dated 3 September 1961[9] describes the relief elements of the finish that, depending on the angle of the sun, reflect light "to create effects that change depending on the vantage point from which the building is observed"[10].

The possibility to render the perception of color on the façade vibrant and never constant with the variation of light and the position of the observer can also be found in Ponti's designs for the Politecnico di Milano

[5] CSAC, Fondo Gio Ponti, Tempio votivo di San Francesco, Milano, 1960-1975, coll. 325/4, inv. PRA 610, id. 14173.
[6] CSAC, Fondo Gio Ponti, Tempio votivo di San Francesco, Milano, 1960-1975, Particolare facciata tempio sul sagrato, 30 maggio 1961, scala 1:20, coll. 325/4, inv. PRA 610, id. 14173.
[7] CSAC, Fondo Gio Ponti, Tempio votivo di San Francesco, Milano, 1960-1975, Particolare facciata. Casa parrocchiale sul sagrato, 28 aprile 1961, scala 1:20, coll. 325/4, inv. PRA 610, id. 14173.
[8] CSAC, Fondo Gio Ponti, Chiesa di San Carlo Borromeo all'Ospedale San Carlo, Milano, 1961-65, coll. 329/1, inv. PRA 844, La chiesa. Facciata principale, 3 settembre 1961, scala 1:100.
[9] Advertising page of Ceramica Joo Milano srl, 1966. Domus 443 (October): 2.
[10] CSAC, Fondo Gio Ponti, Politecnico di Milano, 1955-1963, coll. 338/5, inv. PRA 590.

(1955-1963)[11] and in particular for the building known as the *Trifoglio* (1959-1963), suspended above a rusticated bush hammered concrete base and finished, on the upper levels, in very shiny and faceted dark grey Joo mosaic tiles.

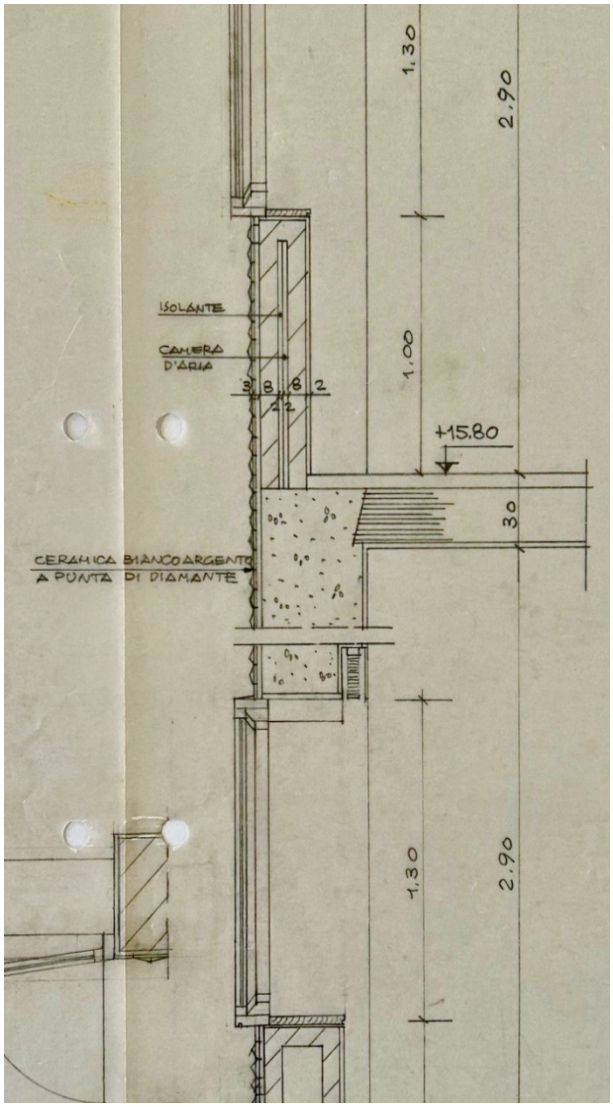

Fig. 4 Studio Ponti Fornaroli Rosselli, Façade detail. Parish residence facing the church square, 28th April 1961, scale 1:20 (part.) © CSAC Centro Studi e Archivio della Comunicazione, Università degli Studi di Parma, Fondo Gio Ponti.

However, it was in the field of corporate architecture that Gio Ponti struck a balance between a consolidated language and more daring experiments. The drawings for the Second Montecatini Building (1947-1951)[12] dating back to 1947 show ceramics used in small diamond tiles and plain tiles cladding the façade facing via Principe Amedeo, flanked by taller volumes finished in slabs of Nuvolato Apuano stone with a bush hammered concrete base[13].

In Montedoria office building (1970) Ponti, now in his nineties, amplified the theme of color by modeling a volume whose façades are defined by vibrant green scales and the alternation of large openings and smaller windows (Fig. 5). The project drawings, dated between 1968 and 1969[14], do not arrive this time at such a high level of detail for the surfaces. All the same, the earliest drawings already show the choice to use "green ceramic elements 6×19.5 cm, both flat and in relief" that would be indicated in 1969 as Superklinker tiles by Saccer company, alternating with "surfaces in scraped white cement", bands of glass block and "natural anodized aluminum windows" by Securit [4].

The variations of light during the course of the day emphasize the geometric and chromatic differences of these choices: "what is differentiated in this case are the diamond reliefs, some set inward others projecting, others with a double faceting, with a narrower relief containing 'two diamonds' per tile" [14].

The green mosaics with different shades and marbling were previously used by Ponti at the Bijenkorf warehouses in Eindhoven (1964-1968), produced to his design by Saccer company. The same cladding can also be found on the Savoia Assicurazioni building (1968-1971) in Milan, the last building realised by the architect.

[11] CSAC, Fondo Gio Ponti, Secondo Palazzo Montecatini, Milano, 1947-1959, coll. 328/2, inv. PRA 700.
[12] CSAC, Fondo Gio Ponti, Secondo Palazzo Montecatini, Milano, 1947-1959, Facciata su via P. Amedeo, 4 marzo 1957, scala 1:100, coll. 328/2, inv. PRA 700.
[13] CSAC, Fondo Gio Ponti, Edificio Montedoria, Milano, 1968-1969, coll. 325/1, inv. PRA 852, id. 14522.
[14] CSAC, Fondo Gio Ponti, Edificio Montedoria, Milano, 1968-1969, Facciata su via Andrea Doria fianco su Piazzale Caiazzo, 18 giugno 1963; Facciata su via G. B. Pergolesi, 9 aprile 1968, scala 1:100; Facciata su via A. Doria, 31 ottobre 1969, scala 1:50, coll. 325/1, inv. PRA 852, id. 14522.

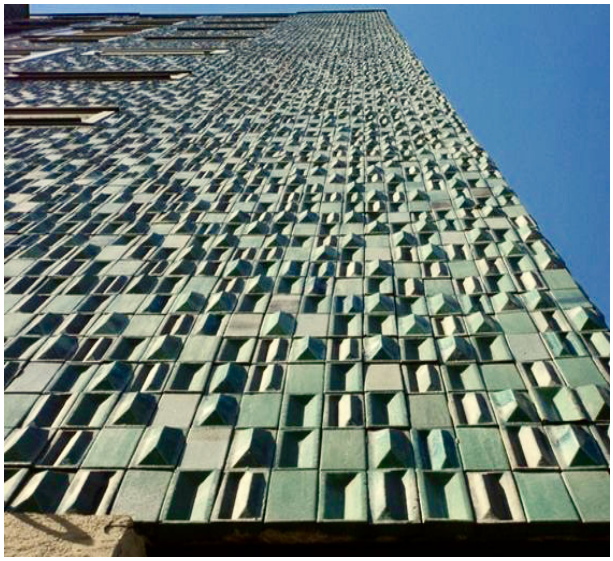

Fig. 5 Studio Ponti Fornaroli, Montedoria office building (1970), four different types of green ceramic tiles (Di Resta 2021).

2.4 The Deterioration of Ceramic Surfaces

In Gio Ponti's writings, the dialogue established between ceramics and architecture is motivated, other than by aesthetic characteristics, also by requirements of durability and hygiene guaranteed by the choice of this material. Particularly in polluted environments, such as large cities, ceramic surfaces would offer a valid and more durable option than plaster.

These finishes now represent an important material, technical and artistic legacy for modern architecture, capable of documenting art, experimentation and industrial innovation. All the same, despite the excellent intrinsic properties of ceramic materials, they are frequently subject to deterioration that can take the form of cracking, spalling, detachment and falling elements that represent a risk to the integrity and efficiency of modern surfaces. The causes of these phenomena are not generally due to physiological aging, but instead to errors in design or installation. The principal causes of deterioration include:

- incompatibility between surface and substrate;
- deterioration of the substrate (cement or adhesive based on vinyl or acrylic resins) or of the sealants (erosion, calcium hydroxide washout in cement mortars, action of acid substances, carbon dioxide or sulphates on cement mortar)
- application to supports affected by problems of rising dump;
- poor quality of materials.

The notable difference in the elasticity of surfaces and supports is generally the first cause the deteriorations mentioned. Thermal movement of the finish material is in fact impeded by the leveling and/or adhesion layer because the elastic module of these mortars (or resins) is inferior to that of ceramic tiles (Fig. 6). The constant action of movement causes spalling, detachments and falling [15].

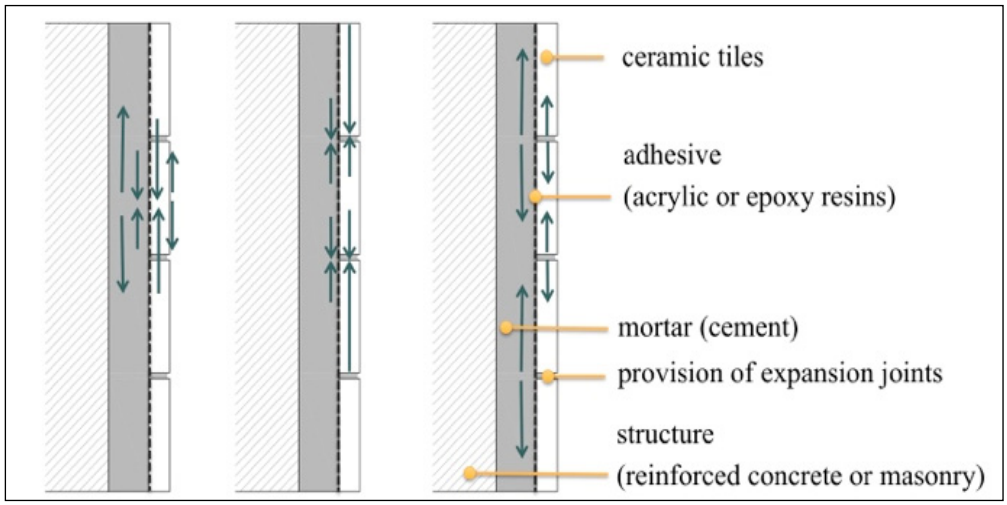

Fig. 6 Ceramic surfaces. Deterioration phenomena related to the installation methods (Di Resta, 2023).

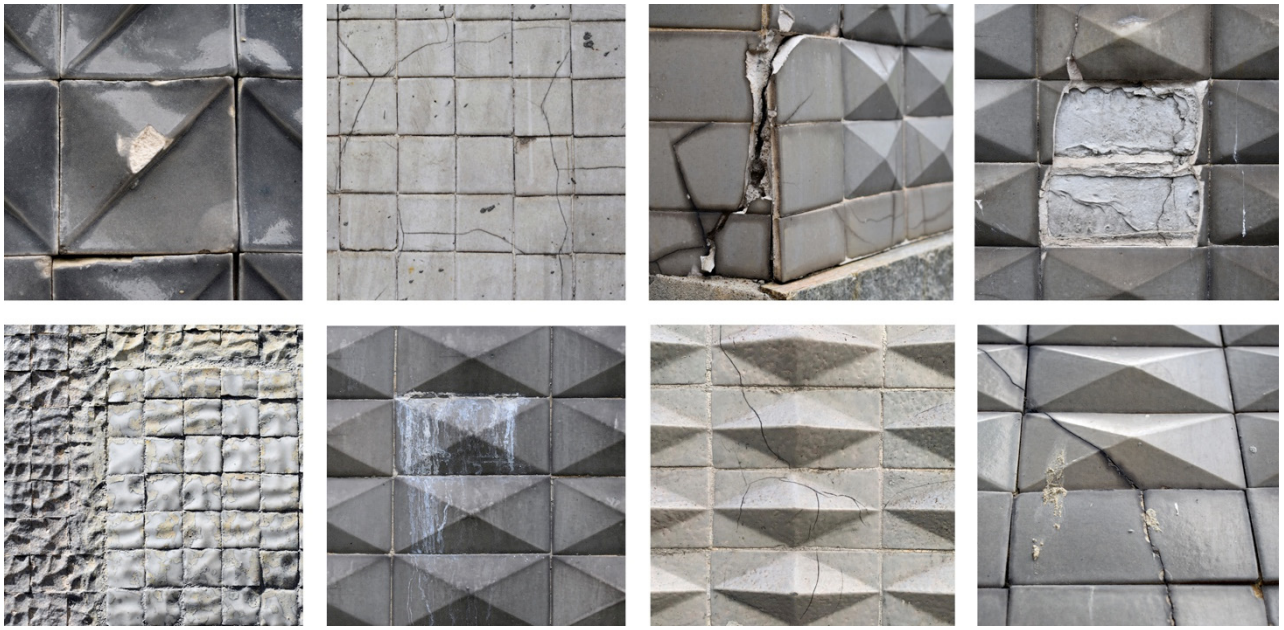

Fig. 7 Deterioration phenomena of modern ceramic surfaces. From top left: (a) expulsion of vitrification of glazed finishes; (b) hair cracks of unglazed porcelain tiles; (c) fractures of unglazed porcelain tiles due to the expulsion of concrete cover; (d) detachment and falling of mosaic tiles; (e) visually evident repair works; (f) deterioration of the cement mortar (substrate); (g) hair cracks on "diamond" unglazed porcelain tiles; (h) fractures on "diamond" unglazed porcelain tiles (Di Resta, 2021).

While the deterioration of the support that can lead to detachments and falling of tiles is a common issue for façades with a ceramic finishes, the analysis of Ponti's architecture in Milan highlights significant differences in the behavior and related state of conservation of surfaces in relation to the diverse supports to which the tiles are applied (Fig. 7).

A particularly explicative example is offered by the finishes of the St. Carlo Hospital Chapel [16], where there is an evident difference in the state of conservation of the mosaics installed on reinforced concrete and those on masonry infill walls. The first shows serious and widespread phenomena of cracking caused by the expulsion of the concrete cover (Fig. 7c). Diversely, tiles applied to infill walls show a lesser extent of deterioration limited to the cement mortar and/or the adhesives, generally the cause of detachment and falling of entire mosaic tiles (Fig. 7d).

While the unglazed porcelain tiles (grès) is characterized by the scarce absorption of water and a good chemical resistance and resistance to freezing, the same is not true of glazed porcelain tiles. A specific phenomenon related to this material is the deterioration of the enamel finish (Fig. 7a), which does not generally suffer from alterations when properly protected against the effects of atmospheric agents and sharp changes in temperature, but shows diffuse phenomena of cracking and expulsion of vitrification when placed outside.

3. Conclusions

Ceramic surfaces are among the most expressive materials in the work of Gio Ponti, a "generous and powerful champion of modernity and renewal"[15].

All the same, his buildings in Milan are only an important sample of a much vaster phenomenon, demonstrated, in addition to the numerous buildings designed by Ponti around the world, also on ceramic surfaces of many works that constitute an important legacy of modern architecture. This heritage of

[15] The company TeamWork Italy, specialized in reproduction of modern ceramics, mosaics and klinker tiles for restoration works, has provided the tiles for the mentioned interventions.

technical, artistic and architectural culture is now at risk of being lost, due to a lack of systematic studies on the conservation of the unique materiality of the buildings.

In many cases, the deterioration of modern surfaces has led to widespread and extensive works of substitution, in some cases integral, nurturing a new market for the production and re-production of tiles for the restoration of modern architecture.

In Milan, different degrees of replacement of mosaic tiles have been carried out at the St. Carlo Hospital Chapel, now St. Maria Annunciata (glazed porcelain mosaic tiles "diamond", grey color, 7.5×15 cm), the *Domus Adele* (clinker relief tiles, mustard color, 10×20 cm), the Montecatini building (glazed porcelain mosaic tiles, white color, 2×2 cm; "diamond" clinker tiles, grey color, 6×12 cm, in 4 typologies: relief, bas-relief, high bas-relief and flat), the Montedoria office building (glazed porcelain mosaic tiles, variations of green, 6×19 cm), the *Nave* and *Trifoglio* buildings at the Politecnico di Milano (glazed porcelain mosaic tiles "diamond", grey color, 7.5×15 cm; relief mosaic tiles, dark grey color, 5×5 cm) and the former Savoia Assicurazioni building (enameled green relief mosaic tiles).

Both economic reasons (high cost of conservation work) and the need to retain the visual integrity of modern architecture are among the principal causes of replacement works that represent the true risk of losing ceramic surfaces.

The ongoing research is aimed at providing a systematic characterization of phenomena related to the deterioration of modern finishes, nurturing successive investigations and exploring possible new strategies for conserving the elegant and distinct skin of 20th century architecture.

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Journal of Civil Engineering and Architecture 17 (2023) 574-581
doi: 10.17265/1934-7359/2023.11.009

Terranova Render: A "Polychrome Resource for Modern Aesthetics". A Study for Analysis and Characterization

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Abstract: The industry, which developed into an endless source of new formulations and technologies, supported the typological innovation that took place in the architectural field in the first half of the 20th century. The world of plaster was revolutionised by the introduction of ready-mixed mortars that only required the addition of water. The plaster was no longer created on site, and the workers only dealt with the application. In Italy, the so-called "special plasters" based on cement and/or lime with the addition of various substances, the formulations of which were kept secret by the manufacturing companies, appeared in the period after the World War I. Despite being widely spread, their composition is still little known today. Samples of Terranova plaster, characterized by high durability, were investigated in this study to understand their main characteristics. The analysed samples appear to be based on dolomitic lime with characteristic iridescent aggregates and high porosity, probably due to air-entraining agents and pigments based on oxides of different nature. The aim of this paper is to compare three samples of Terranova plaster from the Emilia-Romagna region with the literature.

Key words: Terranova plaster, modern heritage, material characterization.

1. Introduction

Literature on modern heritage materials, although now conspicuous, is lacking in many aspects, mainly due to the huge number of materials introduced during the 20th century. The so-called "special plasters" [1] based on cement and/or lime (with the addition of various substances) appeared in Italy during the first post-war period, the manufacturers of which kept the formulations secret. The innovations introduced during the 20th century led to not always adequate outcomes, being many modern materials characterized by a high degree of experimentation which easily led to their deterioration. On the contrary, Terranova plaster was characterized by high durability [2, 3].

In this study, a series of diagnostic investigations were conducted in order to understand if some samples of Terranova plaster match the properties declared by the manufacturer and if there are recurring characteristics among different samples. The ultimate objective is to understand whether there is a sort of "standard recipe" that allows reproducibility nowadays.

2. Terranova: A Ready-Mix Rendering Mortar

Engineer Carl August Kapferer founded the business Terranova Industrie C.A. Kapferer & Co. in Freihung, Germany, in 1893. The founder, in collaboration with Wilhelm Schleuning, started the production of Terranova render, a ready-mix colored render [4].

The first patent was presented to the imperial patent office in Berlin on November 19, 1895, and was registered on March 12, 1896, at no. 14702 (class 37). The popularity of Terranova plaster grew over the years, and new factories were opened in Munich, Frankfurt, Berlin, Nuremberg, and Vienna [4, 5]. After widespread

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diffusion throughout Europe, Terranova plaster arrived in Italy thanks to two industrialists: Aristide Sironi and Federico Griesser.

Sironi registered the "process for improving plaster mortars" in 1928 with industrial patent no. 247015 of the Kingdom of Italy.

In 1932, Sironi, Griesser, and Kapferer founded the Società Anonima Italiana Intonaci Terranova and started the production in Italy. Meanwhile, a new logo was registered at the central state archive, which underlined the presence of the product on the market since 1893[1]. With the opening of the factory in via Benaco in Milan and the presence of representatives in the major Italian cities, Terranova plaster found applications throughout the Italian peninsula. Since the first year of its establishment, the company participated in Milan's *Fiera campionaria*, where national products were promoted, and their modern and rational qualities were exalted. Thanks to widespread advertising campaigns in sector magazines, durability, resistance to atmospheric agents, the vast range of colors, and the autarkic restrictions imposed by the fascist regime, Terranova became the reference plaster for the designers of the time. Used not only for exteriors but also for interiors with "a thousand and more very soft colors, it gives the architect and the builder the resource of polychrome and modern aesthetics", according to a 1930s advertisement that appeared in many magazines, including Domus [5]. The use of Terranova also reached the world of art, and decorative inlay panels of Intonaco Terranova were exhibited in 1933 at the *Mostra dell'abitazione*.

Another key year for S.A. Intonaci Terranova was 1936, when they opened the factory in Stephenson Street in Milan and the factory in Civitavecchia, which was then closed in 1956. In 1945, the Sironi family took over the shares of Griesser and Kapferer, and the property became entirely Italian: the Italiana Intonaci Terranova S.p.A.

The Sironi family's path at the helm of the Italian Terranova company ended in 1987, when the Austrian Terranova company took over all the shares. In 1993, the French company Weber & Boutin, a European leader in the production of colored and premixed plasters, purchased the company, which is now owned by Saint-Gobain Weber Co. [5].

2.1 Composition

Being subject to patent, the composition of Terranova plaster remains secret; however, among many uncertainties about its composition, it can be stated that since its origin the Terranova plaster produced in Italy has been a ready-mix powder mortar, i.e., a ready-to-use dry mortar, which only requires the addition of water for application. Some variations of this secret formulation, investigated by several studies in recent years, seem to emerge over time.

Before arriving in Italy in the late 20s, in Germany, Kapferer started to produce for the first time a ready-mix factory-colored dry mortar in 1911. It only needed water on the building site, probably to have more precise control over quantities but also to meet market demand for ease of installation.

Furthermore, in 1911, a new patent was issued for a "method of improving the permeability to air of dry plastering-mortar", adding a "mixture of oil, acetone, and starch additives" [6].

In the first German formulations, according to studies conducted on patents [6], "clay (kaolin), feldspar (orthoclase), lime, and pure quartz sand were burned to produce cement clinker".

In 1926, another improvement was made to give it a sparkling appearance by adding iridescent aggregates.

Research by the University of Potsdam [4] shows that white Portland cement was available on the German market only in 1926, long after the birth of the company and the start of marketing Terranova plaster throughout Europe. Since the manufacturer Terranova

[1] The trademark n. 46679 of the S.A. "Terranova" plasters was registered on October 18, 1932, in Milan to identify petrifying plaster for building use and registered on December 6, 1933, at the Archivio Centrale di Stato.

stated in 1990 that the product had not undergone changes since 1893 [5], it seems that, at least in the first formula, the binder did not consist of any quantity of white cement.

According to a manufacturer's technical data sheet, reported in Ref. [5], which claims to still produce Terranova according to the original formulation, it is reported that the plaster "is made up of a mixture of lime with the addition of a small quantity of cement, selected silica and quartz sands, and solid inorganic pigments to the light, which allow its production in a vast range of colours". However, it is not possible to define the nature of these binders and the aggregate-binder relationship.

An innovative aspect of the patent registered in 1928 in the Kingdom of Italy is the ability to start the silicatization process of the lime during hardening by adding powders of active silicic acid and sodium or silicon fluoride.

2.2 Color Chart and Application

In 1934, Griffini defined Terranova plaster in his dictionary as "plaster prepared with special substances and colored with natural pigments. (...) It presents an extensive variety of different colors and shades" [1].

In 1893, since the first stage of production, Terranova render was "offered in the colors yellow, light red, dark red, silver gray, yellowish, greenish gray and reddish, initially using different colored brick material" [4].

The handbooks of the 1930s report that the plaster was colored with natural pigments; however, as regards the color, there seems to be a first phase where, in addition to the binders used, which had a great influence on the coloring, there were additions of bricks, slate, chalk, ironstone, slag, molten brick, finely ground glass, and porcelain [4]; a second phase, however, was characterized by the use of "light-fast inorganic pigments that allow the production of a vast range of colors" [7]. The information contained in a patent specification also shows that the result, in terms of color, of a plaster mortar did not only depend on the choice of pigment but also on the method of addition [4].

The information provided by Griffini can be found on the back of an advertising flyer from 1932, which states that the product is sold in 50 kg paper and jute paper bags and in 90 colors, which are delivered to the construction site in ready-to-use bags and only have to be mixed with water. It is also reported that the application requires a few simple phases: spreading the mixture with a trowel, troweling, smoothing at the beginning of setting, and finally brushing.

The bladed Terranova "lamato", with its 5 mm thickness, was supplied in three grain sizes: fine grain with a yield of 7 m^2 per quintal, medium grain with a yield of 5 m^2 per quintal, and large grain with a yield of 4 m^2 per quintal.

The application by the company selling the product, in order to guarantee correct application, was continued until the 1980s.

3. Materials and Methods

3.1 Specimens

This paper illustrates and discusses the chemical-physical analyses carried out on specimens of Terranova render collected from three rationalist buildings in Emilia Romagna region:

- ex Mercato Ortofrutticolo (M.O.F.) in Ferrara (1937-1938);
- ex Gioventù Italiana del Littorio (G.I.L.) in Forlì (1933-1935);
- ex Asilo Santarelli in Forlì (1936).

Archival documentation supported the authenticity of the first two renders, but there was no firm evidence for the third. All these samples were compared with the previous study on the "Terranova" render of the Engineering Faculty in Bologna (1931-1935), which showed that almost a century after its application and despite direct exposure to rain, this render is in a perfect state of conservation [2].

Another interesting basis for the comparison is a specialist report relating to the restoration project of "ex

Asilo Santarelli" carried out by Istituto Giordano[2]. The MOF-1 sample (Fig. 1) shows a light green upper layer with an irregular surface and a thickness of approximately 2 mm and a light grey substrate with a thickness of approximately 14 mm. The sample taken from ex-GIL (Fig. 2) exhibits sparkling aggregates, and while the thickness of the colored layer increases considerably, reaching 7 mm, while the substrate settles at around 15 mm. Asilo Santarelli (Fig. 3) has a thickness of 3 mm in the colored layer and 15 mm in the substrate.

Fig. 1 Sample MOF_I taken from ex Mercato Ortofrutticolo (M.O.F.) building in Ferrara.

Fig. 2 Sample GIL_I taken from ex G.I.L. (Gioventù Italiana del Littorio) building in Forlì.

Fig. 3 Sample ASL_I taken from ex Asilo Santarelli building in Forlì.

3.2 Testing Methods

3.2.1 Porosity and Transport Properties

The ability of substances to be conveyed within a material is a function of pore quantity, size, and distribution. Knowledge of the void network, together with other properties, allows carrying out assessments both on the degradation mechanisms and on the requirements necessary for conservative treatments to be effective, compatible, and durable.

Hydrostatic weighting was used to determine real density and apparent density, total porosity, and open porosity, as illustrated in EN 1936 [8]. A water pycnometer was used on powdered samples to determine the real (or absolute) density.

Water absorption by capillarity was determined as described in EN 15801 [9]. After drying the samples to a constant mass, the samples were placed in a vessel with a bedding layer of gauze soaked in deionized water. The surface chosen for the determination of water absorption by capillarity was not polished in order to keep the typical roughness of the surface. The samples were weighed at appropriate time intervals.

The water vapor diffusion resistance coefficient of the render (μ) was determined by the wet cup method using a saturated aqueous solution of KNO_3, according to EN 12572 [10]. The test was carried out on the

[2] Attachment R4: Bando no. 2150 of 28.9.2018 of the Municipality of Forlì, "Analisi petrografica, analisi diffrattometriche, analisi al microscopio elettronico su campioni di intonaco esterno e determinazione della presenza di amianto su materiale massivo".

samples made up of two layers, without separating them.

M.I.P. (Mercury Intrusion Porosimeter) Thermo Scientific Pascal 240 and 140 allowed obtaining information on the quantity, size, and distribution of pores through the intrusion of mercury at increasing and isotropic pressure.

3.2.2 Composition and Formulation of the Render

In order to observe a flat cross section of the samples in an Olympus SZX10 S.O.M. (stereo-optical microscope), they were incorporated into resin, sawed, and lapped. This allowed determining some morphological characteristics, colors, and the state of conservation.

The samples were also studied in cross-section and on the external surface with a SEM (scanning electron microscope) Philips XL-20 equipped with EDS (energy dispersive spectrometer) microanalysis.

The Dietrich-Fruhling Calcimeter was used to determine the content of $CaCO_3$ (calcium carbonate), according to UNI 11139 [11] and UNI 111402 [12]. Different fragments were analyzed and they were identified by progressive numbers. Each sample was divided into its two layers, the colored one and the substrate, and crushed with the aid of mortar and pestle. To carry out the test, 1 g of powdered sample was used for each layer. Grinding facilitates the reaction between $CaCO_3$ and HCl, increasing the surface area of the sample in contact with the acid.

4. Results and Discussions

Open porosity, as shown in Table 1, is higher in the colored layer than support for samples MOF-1 and ASL_I-2. Comparing the data obtained with those carried out on the single-colored layer in Ref. [2], characterized by an open porosity of 22.9% defined through hydrostatic weighing, it can be noted that the only GIL-1 sample with a porosity of 25.33% is in line with this result, while the other samples exhibit higher porosities [7]. It is interesting to observe how the colored layer of the analyzed samples does not have a lower porosity than the support, unlike what is expected for historical plasters.

The water vapor diffusion resistance coefficient (μ) of the MOF-1 sample is less than half with respect to GIL-1. Terranova plaster of the Faculty of Engineering in Bologna was studied only in the colored layer, so a comparison should be avoided since this test on MOF-1 and GIL-1 was conducted on the plaster made up of both layers.

Technical characteristics provided by the manufacturer and reported in Ref. [5], indicate $\mu < 16$ for bladed Terranova "lamato" and $\mu < 4$ for sprayed Terranova "spruzzato", but there is no reference for these values, and therefore it is not possible to deduce from the text whether these are experimental values obtained in research or whether they were taken from handbooks. In both cases, the manufacturer's values refer to laboratory tests on hardened mortars, but it is underlined how the coefficients could be modified depending on the installation methods. Based on these data, only MOF-1 with a value of 7.7 is in line with the results obtained. The UNI 10351 [13] provides reference values for vapor permeability from 5×10^{12} kg/(m·s·Pa) to 18×10^{12} kg/(m·s·Pa) for lime or lime and cement-based mortars with a density of 1,400 kg/m^3 and cement mortars with a density of 2,000 kg/m^3.

Table 1 Open porosity measured with hydrostatic weighting (%P.A.$_{hw}$), open porosity measured with MIP (%P.A.$_{MIP}$), mean pore size (ϕ), bulk density (ρ_b), real density (ρ_r), capillary water absorption coefficient (C.A.), and water vapor diffusion resistance coefficient (μ) of Terranova samples. C: colored layer, S: substrate.

Sample	MOF-1		GIL-1		ASL_I-2	
Layer	C	S	C	S	C	S
%P.A.$_{hw}$	34.04	27.72	25.33	31.73	31.71	26.98
%P.A$_{MIP}$	32.86	30.89	28.28	24.66	31.30	33.66
ϕ	0.13	0.33	0.20	0.32	0.30	0.43
ρ_b	1.70	1.76	1.87	1.72	1.68	1.76
ρ_r	2.56	2.52	2.44	2.48	2.45	2.61
C.A.	0.068	0.078	0.056	-	0.128	-
μ	7.7	-	16.1	-	-	-

The capillarity water C.A., reported in Table 1, was analyzed in both directions only for MOF-1 sample, since the extremely irregular surface of the other samples would not have provided reliable results. The values are similar to the 0.068 kg/($m^2 \cdot s^{1/2}$) value found for the Faculty of Engineering in Bologna, while ASL_I-2 shows substantially different results compared to those present in the literature. However, it is noteworthy, as emerged from historical research, that the Terranova plaster itself existed in various formulations. The reduced value could be due to the presence of water-repellent organic additives or the presence of air voids that limit capillary absorption in the short term since they are filled only after the smallest pores and capillaries are saturated [2].

In Table 1, the values of bulk density (ρ_b) are also shown, which are in line with those provided by the Italian standard 10351 [13], in which lime-based mortars are characterized by a density of 1.8 g/cm^3. The test results are also similar to those provided by the manufacturer and reported in Ref. [5], equal to 1.7 g/cm^3. In Ref. [2], the density of the finishing layer is equal to 1.82 g/cm^3; the value is very close to that obtained for the sample GIL-1, but also the other tests on MOF-1 and on ASL_I-2 provided values in the same range.

In Table 1, the values obtained from the performed pycnometry are summarized. The coloured layer is found to have a higher actual density than that of the support only for the MOF-1 sample; the other samples analysed have higher values in the substrate than in the coloured layer.

M.I.P. test results are summarised and illustrated in Table 1 and Fig. 4. The %P.A. of the sample in Ref. [2] is slightly lower than those of the samples analyzed in this study; the most similar is GIL-1 with a value of 28.8%, while MOF-1, with the value of 32.86%, is the one that differs most. The average diameters of the pores of the analyzed samples are all smaller than the sample studied in Ref. [2]. The samples ASL_I-1 and MOF_1 have a cumulative pore size distribution curve more similar to that of hydraulic lime mortar, while the sample GIL-1 has a curve similar to the one of cement-based mortar [2]. However, cement-based mortars usually have porous diameter in the range of 0.002-0.1 μm, while, the sample GIL-1 has a peak between 0.2 and 1 μ m, in line with NHL mortars.

The observation with the optical microscope showed that all the samples are characterized by a rough external surface and perfect adhesion between the two layers. The irregularity of the surface appears to be a function of both the granulometric assortment and the methods of application. The thickness of the colored layer of GIL-1, equal to 6.5 ± 2 mm, is the highest among the samples, and higher than that suggested by the manufacturer. The literature values are in line with those observed in the ASL and MOF samples. The presence of iridescent aggregates, probably mica as in Ref. [2], was found in samples MOF-1, MOF-3, and GIL-1. In MOF-1 and MOF-3 iridescent aggregates are very widespread, while in GIL-1, they take up larger sizes compared to the MOF but in smaller quantities. The colored layer of GIL-1 has an aggregate size of up to 5 mm. The aggregates of the colored layer of the other samples have smaller size; samples MOF-1 and MOF-3 have a maximum size of approximately 0.5 mm, while the aggregate size of samples ASL_I-1, ASL_I-2, and ASL_II-1 is about 1 mm.

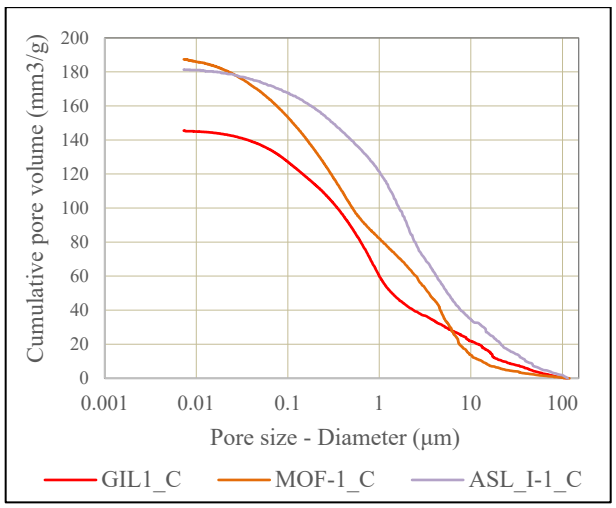

Fig. 4 Results of the M.I.P. test on the colored layer.

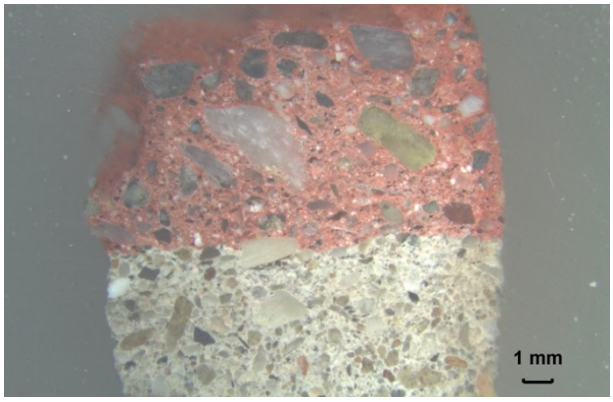

Fig. 5 SOM image of the Terranova render of ex G.I.L. building in Forlì.

EDS spectra show the presence of O, Si, Al, Mg, Ca, and C, although the aluminum peaks in all spectral spectra are due to the Al sputtering over the samples. Samples from Asilo Santarelli show similar spectra for coloured layers and support. The similarity between the two layers had already been observed with SOM (Fig. 5). This test allows for some hypotheses that need to be confirmed with further investigation about the pigments used for coloring the factory-tinted render. The following elements have been detected: titanium in the ASL_III sample, as well as in Ref. [2]. Titanium dioxide (TiO_2) is a white pigment used in coloring processes since World War I. Iron is in both layers of ASL_III and GIL-1 and in reduced quantities in the colored layer of MOF-1. Iron-containing coloring oxides are very widespread thanks to the possibility of obtaining color gradients from yellow to brown. Chromium was found in the colored layer of the samples MOF-1 and MOF-3. Chromium oxide, Cr_2O_3, is an opaque green-olive pigment.

5. Conclusions

In all three cases, the Terranova render is made up of two layers: the exposed colored one and a grey support. The wide range of colors proposed by the manufacturing company is represented, albeit in a small way, by the tones found in this study. The investigations conducted allow stating that the characteristic roughness of the surface is due not only to the methodologies of application but above all to the large size of aggregate (quartz and silicates). The granulometric distribution and color of the aggregates are not the same in the colored layer and in the support. The colored layer has aggregates with a reduced average diameter compared to those observed in the support, which is formed by aggregates that are better assorted. In the colored layer, there is a very widespread iridescent aggregate, probably mica, as shown in previous studies, which gives the render a bright appearance. The amount and size of this type of aggregate vary from sample to sample. The colored layer thickness is higher in all the analyzed samples in comparison with those declared by the manufacturer.

High open porosity (about 30%) is reflected in some patents of the manufacturing company that declare the use of air-entraining admixtures. The presence of pores, whose shape is variable, seems to guarantee excellent durability by increasing frost resistance, one of the main causes of degradation in modern architecture due to the lively and exposed corners [2]. The high porosity is in line with that of mortars based on natural hydraulic lime, while the average diameter of the pores of the analyzed samples is slightly lower.

The adhesion between the colored layer and the support is excellent, and a good compatibility between the two layers seems present both in terms of porosity and density. Despite the high porosity, the capillary absorption coefficient is low, in line with the values found in the literature for mortar based on natural hydraulic lime. The reduced value may be due to the presence of water-repellent organic additives or to air vacuums that limit capillary absorption in the short term. In conclusion, there does not appear to be a common formulation for the compared samples.

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Journal of Civil Engineering and Architecture 17 (2023) 582-589
doi: 10.17265/1934-7359/2023.11.010

An Important Film: Polychromy in the Pier Luigi Nervi Halls at the Turin Exhibition Center

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Abstract: Hidden by several layers of white paint, the almost forgotten polychromy of Nervi's exhibition halls emerges from historical images, not necessarily intended to document the complex, but rather as a setting for exhibitions, fairs or film and advertising sets. Historical documentation reveals Nervi's presence on the building site and his desire to supervise the finishing phases. The first stratigraphic investigations also testify to his attention color, as well as the subsequent transformations of use. Specific theoretical and technical issues regarding the conservation of the pictorial layers in relation to the conservation of the reinforced concrete elements are outlined. Furthermore, the use of polychromy in combination with the original employment of natural and artificial light sources introduces new facets into the analysis of Nervi's work, offering the opportunity for original reflection. This is particularly true if we consider the impact of the interventions carried out so far, even those considered non-invasive, such as routine maintenance operations and some technological upgrades.

Key words: Polychromy, reinforced concrete, ferrocement, Turin Exhibition Halls, Pier Luigi Nervi, maintenance, preservation.

1. Introduction

The aim of this contribution is to illustrate the path that led to the rediscovery of the polychromy that was used by Pier Luigi Nervi in Halls B and C of the Turin Exhibition Center[1]. First of all, the accurate study of the bibliography and archival documentation made it possible to reconstruct the events which masked the original colors, and to locate the most significant areas *in situ* where direct and laboratory diagnostic analyses could be carried out. The direct analyses made it possible to identify the stratigraphy of the various layers that characterize the surfaces today. Subsequently, chemical-physical laboratory investigations on samples of selected materials characterized the pictorial films and their state of preservation. The analysis confirmed the presence of polychromy defined by Nervi himself on both the cast concrete and the ferrocement. Starting from this important data, a specific reflection was initiated on the problems of conserving the pictorial films and the supporting reinforced concrete. For this 20th-century architecture, it is unthinkable to bring to light the original films hidden under several layers of white paint covering thousands of square meters of surface. Furthermore, the two objectives of on-site safety and the preservation of the reinforced concrete are in conflict with the conservation of the layered surfaces.

Considering issues related to the future use of Halls B and C, with reference to structural analysis (which highlighted the vulnerability of the building with respect to safety issues) and analysis of materials and construction techniques (which highlighted peculiar aspects related

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[1] The partial results of the research conducted in the framework of the KIM Keeping It Modern Planning Grant of the Getty Foundation, 2019 "The Halls of Turin Exhibition Center by Pier Luigi Nervi: a multidisciplinary approach for their diagnosis and preservation" coordinated by Prof. R. Ceravolo, PoliTo-DISEG are presented here. The study submitted in this contribution refers to the Iuav working group (belonging to Cluster-lab Iuav HeModern) involved in the project: Prof. P. Faccio, arch. G. Bruschi, arch. F. Pasqual. The *in situ* stratigraphic analyses and data processing were conducted by *Leonardo s.r.l.*; the diagnostic investigations for the characterization of the materials and pictorial layers by *CMR Center Materials Research s.n.c.*, Vicenza; the consultancy for the cortical protective products on concrete by *Ecobeton Italy s.r.l.*, Vicenza.

to historical, aesthetic and conservation issues), shed light on the above-mentioned conflict. The necessity to prioritize between conflicting objectives is common during the final phase of design choices. To allow safety issues to prevail involves the loss, in this case, a substantial one, of material and constructive data, which are not at all insignificant, but nonetheless subordinate.

2. The Pier Luigi Nervi Halls at the Turin Exhibition Center

The center under study stands on the site previously occupied by the *Palazzo della Moda*, designed by Ettore Sottsass senior between 1936 and 1938, which was bombed in July 1943, during World War II. At the end of the war, the City gave the building to a new organization, *Torino Esposizioni*, which was majority-owned by Fiat. The company entrusted the project for the reconstruction and extension of the *Palazzo della Moda* to Roberto Biscaretti di Ruffia. In 1947, a competition organized by *Servizio Costruzioni e Impianti Fiat* resulted in the integration of Biscaretti di Ruffia's preliminary work with a more detailed structural design. The execution of the project was then carried out by the competition winner Pier Luigi Nervi, through his Roman company, Ingg. Nervi & Bartoli-Anonima per costruzioni.

Announced as "the most beautiful building Italy has ever built", the new Turin Exhibition Center was to host the XXXI Motor Show, scheduled for September 1948. In record construction time of just 9 months, Pier Luigi Nervi built the largest ferrocement construction in the world [1]: a pavilion 110.5 m long and 95 m wide, distributed like a basilica, with a glazed apse 30 m in diameter overlooking the *Parco del Valentino* and with a rectangular floor with no intermediate supports (75 m long × 81 m wide). The space is delimited by inclined pillars, which branch off with brackets to support the galleries above, and is covered by a large vault. The roofing vault of this hall (Hall B, later *Salone Agnelli*) consists of arches made of ferrocement elements prefabricated on site, raised and assembled with a system of mobile scaffolding. The system of wave-shaped prefabricated ashlars (with inbuilt windows) and scaffolding, along with the half-dome roofing of the apse, obtained with cement castings consisting of more than 300 lozenges (also made of ferrocement and produced on site) are patented by Pier Luigi Nervi himself (Fig. 1).

In 1950, *Torino Esposizioni* decided to expand the building's spaces to accommodate the new editions of the Car and Technology Shows, once again entrusting Pier Luigi Nervi with the construction of Hall C. The new Hall (50×60 m) has a pavilion vault supported by four arches, covered with the same ferrocement system as the half-dome of the apse of Hall B (Fig. 2). The perimeter slabs to the roof of Hall C are made of

Fig. 1 Hall B, interior by Aldo Moisio (Private collection, Ing. Ravelli).

Fig. 2 Hall C, International Car Show of 1950 by Aldo Moisio (Archivio Storico Fiat).

corrugated ferrocement beams and provide rigidity along the perimeter of the roof.

Finally, a new extension was built in 1953, which increased the length of Hall B by another four bays [2-5].

3. The Film Sequence That Reveals Polychromy at the Turin Exhibition Center

There are no published or construction site images which show the colors of the Halls. Even in the publications signed by Pier Luigi Nervi the images are in black and white [6, 7]. The use of black and white images was not only due to the possibilities offered by the technology at the time, or due to the need for low-cost printing, but also due to an intention to improve the perception of forms and enhance the role of light, and volume. The author himself never mentions the choice of color adopted for these buildings, instead, he used his writing to promote his patents and his new fast, cheap and innovative construction techniques. Another influence was the revolution dictated by the Modern Movement: the color white became the starting point for a new story, expressing the cleanliness of forms and the principles of abstraction. Elementary geometry was used to aspire to essentialism [8]. The image of white-painted interiors was therefore consolidated. We think this happened because of a misunderstanding of the principles inherent to Modern architecture, along with the widespread circulation of images depicting the Halls which were used during the 2006 Olympics, and other documents showing their current state of neglect in which the structures are painted white (Fig. 3).

The comparative analysis of different historical sources such as archives, images and videos shed light on the use of color, an aspect that is often underestimated. From some sequences of the film “The Italian Job”, filmed in 1969, which has been a fundamental first source for this research, certain colors can be perceived that clearly show how some parts of the building were painted cream, others gray (Fig. 4). What seems certain is the absence of bright white paint.

This initial clue led to the consultation of historical images not necessarily aimed at documenting the Center, but rather as the setting for exhibitions, fairs or film and advertising sets, confirming that Hall B was once multicolored (Fig. 5) and raised doubts about the possible presence of polychromy also in Hall C (Fig. 6).

On closer inspection of the bibliography, it is possible to make a few hints about polychromy at the Turin Exhibition Center. The ferrocement parts, due to their executive precision, are exposed while the cast elements, e.g. pillars and shelves, that support the galleries are plastered and painted with a bright ochre color. This color is also used for the large façade of the entrance both internally and externally [3].

Fig. 3 Hall B, the appearance of the interior in white at present (courtesy of Fabio Oggero, 2022).

Fig. 4 A scene from “The Italian Job” (1969) set in Hall B directed by Peter Collinson.

Fig. 5 Hall B, Flor61, 1961 (Archivio Amici d'Italia).

Fig. 6 Polychrome in Hall C, current state (photo by author).

The forecast expenditure for the project demonstrated that the pillars and other structures in Hall B were colored with *Duranova* plaster. However, no information is given about the specific color that was to be used or its area of application. Specifications state that all exposed concrete surfaces were to be plastered, while prefabricated structures would be treated like the existing one. Contrary to the expectation that the documentation would show no finishings planned for ferrocement, it seems that a finishing treatment was also envisaged for the prefabricated elements.

A document found in Ing. Ravelli's private archive testifies Nervi's presence at the construction site and his desire to supervise the finishing phases. In a letter written by Nervi to the lawyer Gino Poletti, Secretary General of *Torino Esposizioni*, he declares his dissatisfaction with the selected shades. The letter also deals with the issue of plant equipment, which Nervi holds responsible for preventing the legibility of the architecture.

4. The Analysis of the Polychromy: Method and Materials

The analysis phase had two objectives: the first was to define the type and sequence of coatings and colors attributable to the different interventions through *in-situ* micro-destructive testing. The identification of the various layers also aimed to define the execution technique of execution and colors. The second was to characterize the constituent materials of some samples through laboratory investigations.

4.1 Direct in Situ Analysis

The target areas were identified through the historical analysis. So twelve stratigraphic tests were carried out on the coatings in Halls B and C, by *Leonardo srl*, a restoration company involved in this research. We then proceeded with the investigation through direct surveys done with hammers and thin-blade scalpels.

For each layer that emerged, the functional typology was defined (monochrome finish, polychrome decoration, shaving, dull, plaster, etc.) and the color was recorded with a digital colorimeter (NCS ColourPin3, Bluetooth Colorimeter-NCS Colour AB-Stockholm).

At the conclusion of the stratigraphic survey, a relative chronology of the resulting stratifications was defined, which is represented through coating diagrams in which the various layers identified in the different tests are related. The diagrams make it possible to interpret the layers of each sample not as point information, but as an integral part of the complex of buildings investigated in a certain execution phase. The bichromy illustrated in Fig. 7 plausibly represents the original configuration of the perimeter wall in Hall C as well as all the pillars in Hall B (apse and balcony) (Fig. 7).

Fig. 7 Hall C, perimeter wall, sample No. 5: bichromy between the upper part, beige in color, and the brownish skirting (*Leonardo srl*).

The analyses led to the identification of coating and finishing layers attributable to three macro-periods of activity.

Period 1 (from 1949 to approximately 1969) is the original configuration of the finishes, and the oldest among the finishes found. In Hall C it is characterized by a two-tone effect obtained by differentiating the surfaces of the background walls, of light beige color with brown skirting, while the architectural elements are characterized by a dark gray finish. The chromatic configuration of Hall B is comparable to that found in the adjacent Hall C, therefore distinguished by a bichrome obtained by differentiating the light ochre yellow pilaster surfaces with a brown skirting. The other architectural elements are characterized by a layer of finish with rough textures of gray (wave ashlars and lozenges apse).

In period 2 (from approximately 1969 to an unknown date) the original finishes were modified. In Hall C the perimeter walls were painted a dark yellow ochre while in Hall B they were painted a light ochre yellow with a light hazelnut skirting. The architectural elements were painted light gray (Hall C) and ivory and white (Hall B). Moreover, a bright blue maintenance layer was found on Hall B's lozenges apse and a very bright yellow color on Hall C's arches.

Period 3 (from an unknown date to the present day) is related to the current appearance characterized by a two-tone effect obtained by differentiating the surfaces of the back walls, which are pink-beige, from the architectural elements (pillars, balconies, roofing elements) which are all indistinctly white.

4.2 In-Depth Laboratory Analysis

Petrographic, microstratigraphic and chemical-physical investigations were carried out by the CMR Center Material Research Snc, in order to identify seven significant plaster fragments taken from the interiors of Halls B and C of the Turin Exhibition Center.

The analytical plan employed the following instrumentation:

- Analysis using a polarizing microscope with reflected light on a polished section: to identify the sequence of layers present;
- SEM (scanning electron microscope) analysis accompanied by an elementary chemical micro-wave microanalysis of EDS (energy dispersion electrons) on a polished section: to identify the type of inorganic elements present in the stratigraphic package;
- FT-IR (Fourier transform infrared spectrophotometric) microanalysis: to determine the presence of organic substances.

In all samples, the stratigraphy is complex, characterized by many different layers, which is not easy to correlate between the different samples taken. More specifically, we noticed the presence in all samples of carbonate matrices based on calcium carbonate and less on magnesium carbonate, often mixed with synthetic resins of the vinyl type. If present, pigmentation is based on traditional pigments, such as yellow ochre, green earth and carbon black, with a rounded morphology and fine grain size.

Given the heterogeneity of the samples, it is plausible that there were different phases of restoration or maintenance. To simplify the reading, it was decided to divide the stratigraphic package into two. In fact, it is interesting to note that in all the samples analyzed there is an initial execution phase, based on calcium carbonate and magnesium, sometimes mixed with vinyl

resin (resin not present in the b-c layers of sample No. 2 (Figs. 8-10), in the c layer of sample No. 3 and in the b-c layers of sample No. 7) and a second layer of calcium carbonate mixed only with white titanium particles and silico-aluminate and quartz. In the second period, the layers have a homogeneously distributed microporosity throughout the examined sample, alternating with a macroporosity with relative cavities and blisters caused by the incorporation and subsequent loss of air.

As mentioned above, the coloring of materials was always carried out with traditional pigments; on the contrary, the very bright yellow pigmentation found in sample No. 3, and the layer (d) of intense blue in sample No. 4, essentially based on phthalocyanines, are the result of more recent interventions.

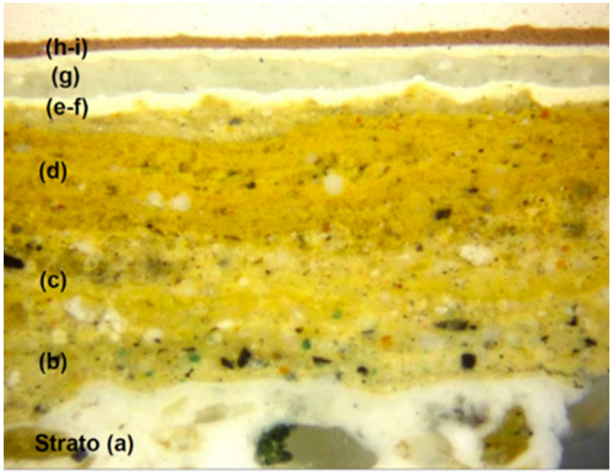

Fig. 8 Hall C, Perimetral wall, sample No. 2, stratigraphic analysis under the optical microscope: "b" and "c" layers without vinyl resins (CMR Center Material Research Snc).

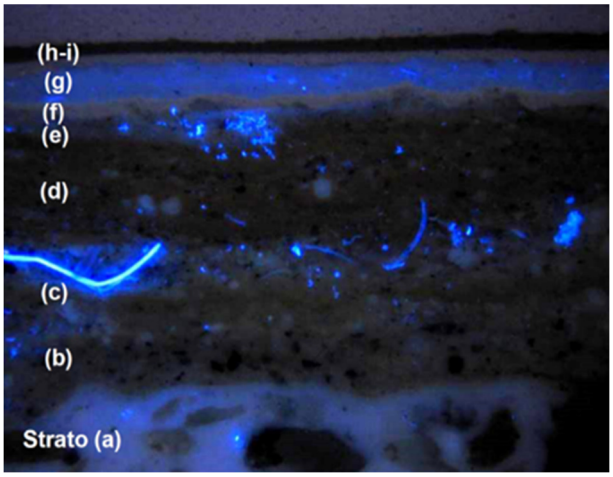

Fig. 9 Hall C, sample No. 2, analysis under the optical microscope with UV (ultraviolet) illumination (CMR Center Material Research Snc).

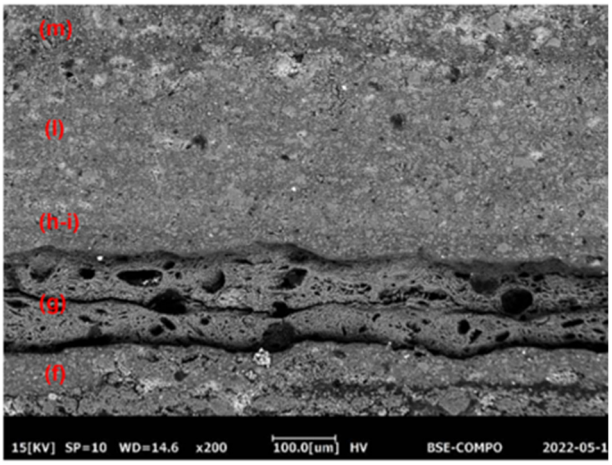

Fig. 10 Hall C, sample No. 2, examination with the SEM electron microscope: layers from "f" to "m" where the alternation between micro and macro porosities is clearly visible (CMR Center Material Research Snc).

5. Results and Discussion

Over the years, the Turin Exhibition Halls have hosted numerous events. Many changes have been implemented: continuous repainting; the updating of technological systems and lighting (often in contrast with the natural and neon light of the original project); the replacement or modification of windows; the closure of portions of balconies on the first or ground floor; and the partitioning of spaces in the stands with plasterboard structures. Ordinary maintenance has been frequent, and has taken place without a coordinated global plan. Maintenance was generally carried out in an ad hoc way, in reaction to the needs of the day or damage that had occurred. Consequently, the original appearance of the Halls has been altered.

The overlapping layers of paint make us forget the original polychromy. White paint is the most recent finishing and the surfaces appear to be uniform. Documentation of transformation over time is largely lacking and the few existing testimonies are limited to some advertising images of past events, which do not allow us to reconstruct the transformations in detail.

Another important change is the fact that in both halls B and C, the entire original neon lighting system of the project was removed.

Finally, over the years, rainwater infiltration has spread, leading to the waterproofing of the extrados of roofs with bituminous sheaths, which however, are no longer effective. Abandonment and the lack of a conservation plan are problems that must be solved, and along with vandalism these threaten the future of the exhibition buildings.

6. Conclusions

In a heritage-listed building such as the Turin Exposition Center, the presence of original layers of paint, documented by indirect sources and by the analyses carried out, poses a challenge to conservation efforts.

First, it is unthinkable to bring back to an original state the thousands of square meters of the interior surfaces of the Halls back to an original state, exposing the colors selected by Nervi.

The three-dimensional reliefs created, together with the historical documentation collected, could make it possible to "see" an overview of the original polychromy in a virtual way, thanks to augmented reality technologies.

Secondly, the current state of neglect, the infiltration of water, the presence of moisture, and incongruous uses have brought about an accentuated degradation not only of the surfaces, but also of the concrete and masonry used as support materials. In addition, protective products for the preservation of reinforced concrete (water repelling, consolidating, migrating anti-corrosive products and techniques) must be applied to exposed concrete, making the choice of methodology even more complex.

At the same time, an experiment aimed at verifying the durability of the ferrocement material, through accelerated aging, was also carried out. Some series of ferrocement samples were treated with protective products provided by Ecobeton Italy srl, in particular migrant inhibitors of corrosion and water-repellent products.

In relation to the presence of original layers, one of the series of samples was intended to test the effectiveness of the migrant products on samples with and without layers of paint.

The structural analysis related to the future use of Halls B and C (which highlighted the vulnerability of the building in terms of safety issues) and the analysis of materials and construction techniques (which highlighted particular aspects related to historical and aesthetic issues and conservation), define a conflict of interests: how can we guarantee the safety of the exhibition spaces without the loss of material and constructive data for not secondary, but however subordinate.

The CMP (Conservation Management Plan), is an operational tool used to support the process of preparatory research, documentation and management of historical sites, for the preservation of cultural heritage. This tool could be useful for collating the variety of issues arising from the knowledge path developed in an interdisciplinary way. A specific CMP for the Turin Exhibition Halls is the result of the KIM (Keeping It Modern) initiative [9, 10]. The promotion of methods and strategies for maintenance and daily management, through the CMP, plays a role of primary importance, especially for the heritage of contemporary architecture, whose fragility and complexity are at risk of getting lost even before they have been totally appreciated and understood in a thorough way.

Before the start of the Getty KIM project on the Turin Exhibitions Center, a specific function for the complex had been assigned. Halls B and C are now confirmed to become a Civic Library and plans for its realization are ongoing. Given the interdisciplinary path of analysis undertaken in our study and the iconic architecture at stake, it is important to highlight and consider some specific issues.

The complex relationship between form, structure and function that characterizes Nervi's architecture is

indeed a critical issue to be addressed. Conservation and safety must coexist in a non-conflicting way, to avoid the prevalence of one over the other and to ensure respect for the original fabric. Safety and conservation should go hand in hand, and this is precisely the approach followed in the preparation of the CMP for the Turin Exhibitions Center.

From the analysis of Nervi's Halls, we found that the definition of a function compatible with the existing building could resolve the conflict mentioned above.

The concept of integrated conservation, introduced in 1975 with the "European Charter of Architectural Heritage" and defined as "the result of the joint action of restoration techniques and the search for appropriate functions" may be of great use in this case [11]. The development of a specific project, for this place, with these characteristics, will have to take into account the vulnerabilities and peculiarities highlighted by the path of knowledge. Intervention can be carried out by way of proper and skilled architectural design rather than with direct actions on materials and constructions. Thus, it is possible to adapt architectural choices to devices that will also solve the contemporary needs of the building.

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Journal of Civil Engineering and Architecture 17 (2023) 590-596
doi: 10.17265/1934-7359/2023.11.011

Landscape and Natural Colors in Architectural Design

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Abstract: The method of research and design that characterized Gellner has been analyzed in depth in this research and his own steps have been retraced on some themes. The uniqueness of his method lies in the way he transformed the data and information gathered into design outcomes on both a large and small scale by reinterpreting traditional architecture and reconstructing elements of the landscape through its shapes and colors. This method applied to town planning also led other planners to use the elements he synthesized within their projects, creating a contemporary landscape for the great event of the 1956 Winter Olympics in Cortina d'Ampezzo. The purpose of this paper is to highlight the importance of this approach to the transformation of the territory and to emphasize the need to preserve these significant works also in view of the new Olympic event that will cross these valleys in 2026.

Key words: Landscape, colors, Edoardo Gellner, Trampolino Italia, ENI Village.

1. Introduction

Color is one of the essential elements that characterize and qualify any landscape. It changes in time through the seasons with different characteristics in each area. In the Dolomite Mountains (Italy) colors change every season and their transformation is abrupt, from winter's white snow blanket, to spring's fresh green and again from the deep blue of the summer sky to the yellow, orange and red shades of autumn (Fig. 1). In the valley of Cortina d'Ampezzo, this range of hues always stands next to the pink-gray colour of the mountains, that does not change with seasons, and the dark green shades of the Norway spruce (*Picea Abies*) and the Scots pine (*Pinus Sylvestris*) which are both evergreen.

Edoardo Gellner noticed these natural elements from his very first visit to the Ampezzo valley. Through his in-depth method of analysis, he was able to identify several aspects of local rural architecture, which he called anonymous, that tie in with the very structure of the natural environment, merging to create a unique landscape. According to Gellner, landscape is the result of the modification of the natural environment by human activities. His analysis consequently developed through the study of various themes, from architecture to history and demography while also studying in detail agriculture, livestock breeding and the local economy.

However, the most interesting part of his analytical work is how he translates the collected data within his projects to create new architecture, in which one can see the result of his awareness of the context where he worked. His great ability to use the collected data, shapes, colors, town planning, views, historical alignments is at the core of all his work. Today it is important to recognize its value in order to preserve its memory.

Fig. 1 Trampoline Italia, Cortina d'Ampezzo, between the brown orange of the larches and the green of the spruces (Menardi, 2019).

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2. Method and Materials

The first step to understand how Gellner was able to use his analyses and translate them into architectural design requires to understand the method he used when analyzing the context.

The earliest documents showing Gellner's visit to Cortina in the 1940's are some sketches of the architecture and landscape [1]. These early drawings portray specific moments that caught Gellner's attention, but the methodical and accurate approach so clearly noticeable in his later works is still missing.

On April 25 1949, he started working in his new studio in Cortina, and from that moment he began the methodical and organized research on the Ampezzo valley. In the early years of his career he had become famous for furnishing hotel's ballrooms, first in Abazia and later in the Alps in Kitzbühel. His fame brought him to Cortina where, as previously mentioned, he decided to live. In Cortina he was asked to work on architectural projects for the first time, as the construction sector was booing due to the upcoming 1956 winter Olympics.

Gellner's analysis developed simultaneously on several themes. In his watercolors he tries to capture the shape of the landscape, which is marked by several layers. The villages of Cortina form the lowest layer, the forest the middle one and the mountains are the highest layer. This complex and layered context characterizes the Ampezzo landscape, which is nevertheless perceived as one unique element in the single views, a landscape in which nature and man's interventions merge with harmony, which is what prompts him to delve deeper into his research. In these same watercolors he pays special attention to the colors of the various elements of the landscape. The Tofana di Rozes mountain, the protagonist of the painting, is painted in a gray-pink color that contrasts with the white of the snow still present on the northern side. The forest of Pocol is darker compared to the light green of the fields that were used as pastures. The houses are small dark spots that form the lower part of the image. Surrounding them we see the last cultivated fields that will disappear from the valley following the economic transition, well documented by Gellner, from agricultural, forest and pastoral activities to a system based only on tourism.

This image of the Tofana was often portrayed by Gellner through another tool important to him, the camera. The same image has been captured hundreds of times from the same viewpoint, the terrace of his studio, to study the changes in color at different times of the day and throughout the seasons [2].

Gellner's use of photography is extremely interesting as he often used it as a scalpel in an attempt to isolate the different details that make up the context and then study them one by one. He used photography also to create panoramas through a collage of different pictures all taken from a single viewpoint thus completely changing the scale of use of the camera. The panoramic images allowed him to analyze the solar exposure of the Ampezzo valley through the hours of the day and at the solstices and equinoxes. He thus discovered that the historical villages, called "viles", are located in the areas with more hours of sun at the winter solstice. One last use he made of the panoramic images was to study the shape of the different sides of the valley to better understand the entries and the general orography.

Using the camera like a scalpel, Gellner also documented several aspects of the Ampezzo valley context [3] such as a scree that cuts through a mountain pine forest (*Pinus mugo turra*) at the foot of Mt. "Lainores", creating a steep white line that cuts through the deep green of the mountain pine forest. He often paused to capture the phenomenon of "enrosadira", which indicates the very bright pink-gray color that the Dolomites show when the sun rays hit them perpendicularly at dawn and sunrise. He especially focused on Croda Marcora, a mountain placed at the entrance of Cortina.

When analyzing the high altitude pastures, he carefully portrayed the thin discontinuous horizontal

lines which characterize the fields that have been used for cattle grazing for hundreds of years. These horizontal lines result precisely from the cattle moving horizontally on steep field for a long time. This element is a change in the natural context caused by human activity, which is exactly how Gellner defines landscape. He also focused on the different kinds of forests, portraying the different colors of a mixed forest. In autumn, these landscape elements are characterized by the green of Norway spruces (*Picea Abies*), the orange-yellow of larches (*Larix decidua*) and the deep brown of beech trees (*Fagus sylvatica*). Some other pictures highlight the uniformity of forests made of a majority of one or two tree species, a selection of plants also operated by men.

Gellner also used his photography skills to document the change in the landscape which occurred when the economy of the valley changed from mainly rural activities to tourism [4] (Fig. 2).

By comparing some historical images, all taken from the same viewpoint, he was able to study the changes in the landscape from 1909, thorough 1923 up to 1943 and then through the 1950's. Looking at these studies it can be easily seen how the fields have been abandoned by farmers and animals. This new empty space was quickly taken by the forest, which changed the pattern of the lower layer of the valley and also made a few colors disappear: like the light blue of flax flowers and the white flowers of the broad bean. It was precisely the cultivation of broad beans that had led to the construction of vertical wooden frames as high as 10 m with horizontal elements used to dry the beans. These structures, called "arfe", were located near the houses and characterized the Ampezzo landscape.

Fig. 2 The "vila" of Cadin di Sopra one of the places least transformed by the advent of tourism (Menardi, 2022).

All of these tools of analysis were used together with the documentary research conducted in the local historical archives: the municipal one, the parish archives and the documents kept by the *Regole d'Ampezzo*, an ancient form of collective property.

3. Result and Discussion

The previous section reviewed the method of analysis that architect Edoardo Gellner used to study the context where he worked.

In 1950 he was entrusted with the master plan for Cortina d'Ampezzo to be carried out in preparation for the 1956 Winter Olympics [5].

In the early design stage he intensified his research to expand his knowledge of the context even more. At the same time, he used photography as a design tool from the start.

The panoramic images analyzed above were used to create the first design hypotheses. The mapping of the different types of surfaces, wooded areas, fields, ski slopes, villages and all the other elements that make up the landscape were first carried out on the pictures and only later transferred on the actual architectural plans. This method was also applied to the newly designed part: the design hypothesis were sketched and then transferred on these panoramic images of the valley to better understand the implications that each choice would have had in each individual area. By proceeding with this method, Gellner was able to control extremely complex elements, such as the construction of a new road system along with several new facilities and services. The hypotheses were later developed through the technical drawings, then either confirmed or modified and then verified once again on the panoramic pictures as the last step. This method guaranteed that

the project had a high landscape quality, changing the town in terms of services and facilities but without altering the landscape too much, landscape that was then drastically changed by the building boom of the 1960s.

Gellner also used the photographic tool of panoramic images to plan the construction of the "new center" of the town. In this once-free space, he selected some panoramic views which were to remain free from buildings in order to show the surrounding mountains. Once these views had been selected, he worked on the buildings' design, using models to study their dimensions and position, and also checking how they would fit in the views through the use of photo collages (Fig. 3).

Another characteristic of Gellner's work is using color in his projects, choosing colors from the landscape for the facings of buildings. Looking at the Post and Telegraph building "TELVE", for example, he chose the gray-pink typical of "enrosadira" for the facing, along with a sky-blue shade. When designing the "Giavi House", in addition to taking the rigid frame of rural curtain wall structures and building it in reinforced concrete, he used sky-blue and yellow, brown shades inspired by the mixed woods to decorate the different facings of the building. All the elements analyzed during the study phase were taken in consideration, processed and arranged within his architectures, thus constructing this singular working method.

In order to best illustrate how Gellner used these analyses in his projects we will analyze his most famous architecture, the ENI Village in Borca di Cadore. The village is to be considered a unique project: the construction of an entire portion of the Boite River Valley landscape. It was built during the 1950s and early 1960s up until the death of the commissioner of the project, Enrico Mattei.

ENI proposed various potential areas to Gellner, asking him to decide which would be the best one to build the village in. After a thorough study of each area, Gellner judged them all to be inadequate and rejected them. He then suggested the debris deposit on the slopes of Mt. Antelao as a possible area for the project that ENI had in mind. The main reason for his choice being that the area consisted in quite a big scree and a few Scots pines (*Pinus Sylvestris*) and did not carry any specific landscape value, unlike the other areas proposed by ENI.

Gellner applied his method of context analysis from the start, and we can see how this method almost immediately transformed into a design phase. All the structures in the village have an almost flat roof, except for the large communal buildings such as the church, lecture hall, and living rooms. All these small horizontal lines that characterize the steep slope are reminiscent of the lines caused by cattle grazing. This is particularly evident in the front image of the village.

The buildings were designed with a ventilated roof. This technology allows the snow to be kept on the roofs in winter just like the barn structures do. The building structures therefore create a dark image that contrasts to the snow seen in the landscape and on roofs.

The entire village thus turns out to be an element of the landscape itself, as it was conceived to be from the beginning. In fact, despite the huge size of the village (it is composed of 17 pavilions and more than 200 cottages), it is currently hardly noticeable. Only in recent years the windstorm VAIA, which hit these valleys in 2018, made the presence of the village more evident, tearing down an entire forest next to the village, also causing damages to some of the buildings (Fig. 4).

Fig. 3 Panoramic view of Mount Faloria portrayed from the same point as Gellner's panoramas (Menardi 2021 produced in collaboration with Iuav's University Photogrammetry Lab).

Fig. 4 A group of houses in the ENI village photographed by a drone, it can be seen how the snow remains on the roofs and how horizontal lines characterize the landscape (Menardi, 2022).

The entire structure was built taking into consideration the best possible sun exposure. After studying various images of the area to analyze the sun movements through the year, Gellner thus decided to make all the cottages face south.

This project best exemplifies Gellner's work, his attention to landscape issues, his use of the collected information to create contemporary designs from a small to a larger scale, all aimed at improving the context in which his architecture was built.

4. Some Other Key Points and Thoughts

As we have seen above, color is a key element of all Gellner's architecture in the Dolomites. Nevertheless, his works vary in the architectural composition, and the use of color along with the purpose of its use change in each project.

In the ENI village for example, Gellner transforms some of the colors that would only be present in the landscape in specific times of the year into a permanent characteristic of the village. This is not the only purpose for which Gellner uses color though. The extent of this architecture and the somewhat inevitable repetitive design of the buildings could have made the overall project look monotonous. The colony with its pavilions and the countless connecting corridors and ramps, the cottages scattered across the steep slope are all potential standardized elements. In this case, Gellner used color to limit the perception of standardization: the facings in the frame structures are all the same, but the color changes from one facing to the other along with different color combinations, thus giving a unique touch to each corridor and cottage, turning them into very distinctive elements. This approach was applied both to the outer part of the architecture and to the inside. In fact, all the corridors, even internally, are finished in different coolers (Fig. 5).

This choice allows bringing the colors of the outer landscape inside the buildings, while at the same time limiting the feeling of standardized production, making each element of the structure recognizable. In the dormitories, the color of the floor and walls changes for each strip consisting of two beds. This also allows the children to easily recognize their own space in a series of dozens of beds that would otherwise all look identical. This way of interpreting the use of color is very similar to the one Bruno Taut shows in the Hufeisensiedlung in Berlin, where the color of the entrances is always changing in an attempt to make standardization unique [3].

The impact of Gellner's work to identify and use landscape colors in architecture goes beyond the buildings that he designed. The master plan he created for the Seventh Winter Olympics was applied to the entire valley and some of the color elements found in the plan have been used on a larger scale and also in other architectures.

Fig. 5 Polychromy inside the ENI village (Menardi, 2021).

Fig. 6 The trampoline Italia with its polychromes that stand out at sun (Menardi, 2019).

The towering elements such as flag poles and parapets were painted in an intense sky-blue that recalls the summer skies. This was done throughout the valley precisely to give uniformity to the whole context. Even today, many elements still present within the area are painted in the same sky-blue that is called "Olympics blue" by local workers (Fig. 6).

One piece of architecture built for the 1956 Games in which we can still see this use of color is the "Trampolino Italia". The structure, built for ski jumping competitions and used until the 1990s, has now obviously fallen into disrepair. The ski jump is one of the few architectural landmarks in the valley. The mountains are the dominant feature in this scenery and there are only three architectures that can be defined as landmarks in the Ampezzo basin: the ski jump, the bell tower and the military shrine. The ski jump facility is located at the main entrance of the town, and it towers over a glacial moraine covered in conifers. This unique piece of architecture was designed by Professor Piero Pozzati of the University of Engineering in Bologna and built by the Mantovani construction company. The entire jumping area is divided into three main elements: the outrun and the landing area with the grandstands, that together form the lower part of the composition, and the inrun, which represents the upper part. The structure of the inrun was made of partially pre-stressed reinforced concrete and it consists of a 90 m long slender beam, with the highest point of the structure measuring 54 m from the base. The concrete structures were completed in only 73 days, since the construction works started in April 1955, only 10 months before the start of the Games. From a technical point of view the structure of the ski jump is extremely audacious, as the inclined beam has a thickness of only 2.54 m at its thinnest point. This was made possible by the great design skills of Professor Pozzati and the technical skills of the Mantovani company. Color is again a very interesting element of this structure: even though today it is hard to perceive it due to the state of disrepair of the ski jump, it is important to take it into consideration to understand the connection with the landscape. The colors chosen for the inrun are the same as those used in many of the facilities of the 1956 Olympics. This choice follows a specific design goal, which is stated in the official report of the Seventh Winter Olympics, where we read that "The structure has been reduced to its essential profile". This design goal was achieved not only through special and innovative structural techniques, but also through a reasoned use of color. The profile of the inrun is highlighted by the red metal sheet that runs along the edges, which contrasts both with the green trees in the background, and with the white of the main structure. A grey-pink color, which recalls the "enrosadira", was chosen for the elements that are not part of the main structure. Finally, a light sky-blue was used for the finishing elements such as parapets and flagpoles, which would almost disappear when seen against the sky. The striking red profile squeezed between the white of the snow on the inrun and the main structure highlights the main line of this project, while the pink of the take-off (lowest part of the inrun), that lights up with the evening light, makes the ski jump become part of the "enrosadira". The parapets that divided the various sectors of the audience and delimited the access routes were also made of white unbarked birch roundwood so that they could disappear in the white of the snow. This careful use of color is undoubtedly one of the reasons that contributed to the immediate appreciation of such a modern project in a

very conservative environment like Cortina, unlike the above-mentioned Telve palace. In fact, even today, despite its current state of disrepair, everyone recognizes it as a symbol, as opposed to Gellner's works in the town center, which most people still do not understand. One other reason for the community's "acceptance" of this project is the fact that it is not located in the historic town center. Being placed on top of a hill, it is somewhat isolated from everything else, which allows it to be observed on its own without comparing it to other structures.

Looking at this structure, which represents a new element in the complex landscape of the Ampezzo valley, it is clear that the results of Gellner's studies on color were taken up by other designers, who reinterpreted his research and used it in their own works.

5. Conclusions

This research aims to highlight Gellner's ability to turn his research and collected data into design and also to show how he was able to transform his knowledge into architectural composition. The great importance of knowing these dynamics translates in the need of preserving these unique structures, that fit so well in the context, through a restoration project. This very place will host the Olympic Winter Games in 2026: the event will have a positive outcome like it did in 1956 only if it is able to build an equally intense and constructive exchange with the area and the local community.

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Journal of Civil Engineering and Architecture 17 (2023) 597-603
doi: 10.17265/1934-7359/2023.11.012

New Chromatic Taxonomy on Plants and Colors of the Former ENI Village by Edoardo Gellner in Corte di Cadore

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Abstract: This art project, by means of an empirical and experiential research, aspires to visually transfer the relationship that the colors and the architecture of the former ENI Village in Corte di Cadore, designed by Edoardo Gellner, share with the natural environment that surrounds it. The artistic research is based on and expresses the need to proceed by freely cataloging the vegetation that embraces the buildings that make up the village and experiences, in the choice of colors made by Gellner, a particular correspondence with Goethe's "Theory of colors". In conjunction with my artistic research and the production of the images, where the plants are removed from their natural context, an applied study which envisages the design of a flip-open table came to life.

Key words: Art project, Edoardo Gellner, architecture, colors, ENI village, environment.

1. Introduction

This research is the result of an art residency for *Progettoborca*, a territorial enhancement and re-functionalization project activated in 2014 on the former ENI village of Corte di Cadore, whose goal is to develop cultural and identity redefinition researches. *Progettoborca* is a branch of *Dolomiti Contemporanee* (2011), an environment reconfigurator that, operating through contemporary art and culture, provides concrete impulses to the areas of the Belluno and Friulian Dolomites.

The study (2020-2021) focuses and investigates the chormatisms that characterize the architecture of the ENI village and put them in relation with the natural environment created during the construction of the village. "The colour scheme, based on one of these three colours (blue, yellow or red) that characterizes the interiors and furnishings of a particular cottage is repeated at the exterior in the panels and in the architectural details" [1].

Preminent in this work of Gellner is "the constant jump in scale between the details and the general, between the interior and the exterior, between the built and the natural environment" [1]. I have recognized and adopted this approach to develop my research.

Colors are therefore used as fundamental elements that organically unify in an osmotic mutual influence the buildings, the natural environment and the interiors. My goal was to create a contemporary visual project and an applied study to synthesize Gellner's thinking. From his chromatic choices Gellner excludes green, simply because it is already present: I placed the plant world, emblematically represented by the color green, in relation to the color component he adopted.

2. Method and Research

The first step of the process was to extract colors out of the building facades taking into account different qualities of light (Figs. 1 and 2). The result was a palette that I used to create backgrounds where the plant world finds a new setting (Figs. 3-6).

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Fig. 1 Sampling colors at the former ENI Village.

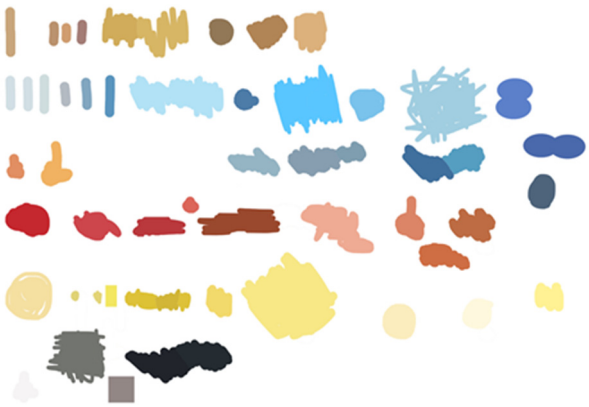

Fig. 2 Digital palette of sampled colors.

In general, every time we look at the color of an object, a wall or a car, we have the arrogance of wanting to define it. That is, we tend to reduce it into a formula or to combine it with a code, in a nutshell we have the habit of abstracting color from the context in which it is found in order to try to objectify it.

We are inclined to do the same with the colors used by Gellner for the architectures that make up the ENI village, it is natural to enclose them in a static collection of samples and archive them there, but observation and experience reveal so frankly and almost banally that even the apparently static dyes of the buildings vary

Fig. 3 Hazelnut.

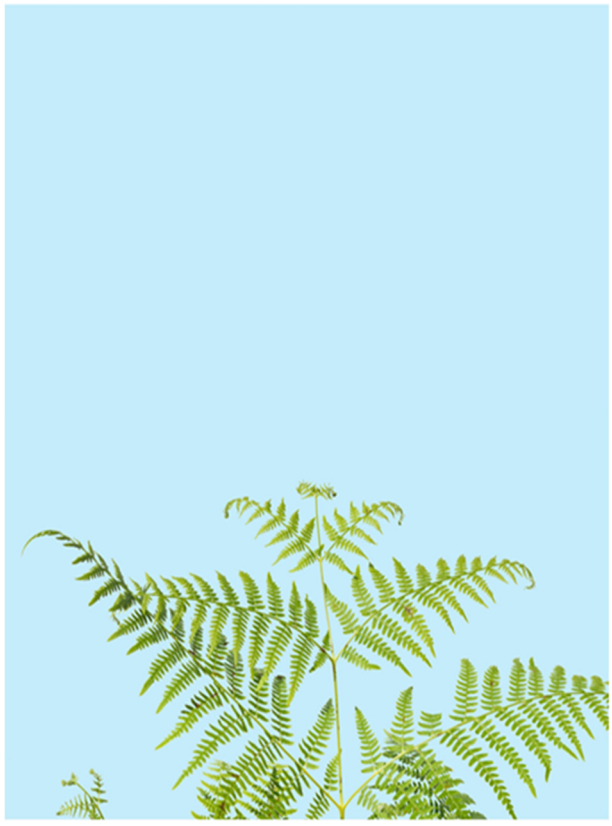

Fig. 4 Fern.

dynamically as the light changes. So I recorded colors photographing them with different quality of lights and shadows.

Goethe said that the phenomenon of color formation takes place in the turbidity that acts through light and shadow, between light and dark and in "The Theory of Colors", yellow and blue are considered the representatives of light and darkness. Again according to Goethe's qualitative thinking, purple, or red, is born from the dynamic combination of yellow and blue. Red is the result of a shining encounter of positive and ascending polarity of the chromatic force.

On the other hand, the meeting of blue and yellow that generates green is different. In this case green is born from an atomistic union which creates a sacrifice of both of these two colors which, by aggregating, mix mechanically. I found a curious coincidence when, carrying on with my research and going up to the campsite to sample the tones and densities of the colors present there, I once again realized that the wooden huts, as well as being white, are actually yellow, blue and red. As already mentioned above, Gellner chose his colors with the intention of creating relationships between the natural environment and architecture through the hues. I deduce that it is precisely to underline the decisive role that color can play in architecture that Gellner seems to want to pay homage to the colors of the area through their presence at the ENI Village.

So that, in finding an expressive modality that could show this relationship materialized by Gellner in his architecture waiting to be surrounded by the greenery that would develop over the years, I also concentrated on the plants.

In my investigation there is no taxonomic or scientific approach (if not partial or incidental), in fact the photographs I have made, although they depict the plant world through an orderly portion of the plant removed from its natural context, show the close relationship that the latter maintains with the colors used by Gellner.

At a second glance, however, the synthesis that I have created potentially contains a decorative motif that has proved to be important for further development of the research which I will discuss later.

I believe that colors have their own voice, that is, they are vectors and manifestations of signs of deep natural and organic processes that far exceed any need for a functional order of the forms that display them. I transferred this element of reflection and made it derive from considering the bodies of the buildings of the Village as places of emanation of color, precisely in the sense just explained above.

In fact, "The characteristic features of the form have a particular morphological value which cannot be understood either with the function of preserving life, or with that of manifesting changes in intimate moods. This morphological value makes visible to us the special nature of each particular organism. The proper qualities, present in the invisible structure of the living substance, i.e. the protoplasm, of a certain species make their influence felt in all the reactions of the blood and also determine the peculiar way of behaving of the species itself; these qualities become evident, expressing themselves in the external appearance. The Dutch Buytendijk, […] once called this meaning of their aspect "*exhibited value of existence*". I called it the "*value of presentation (Darstellungswert)*". Placing the emphasis on the value of presentation should draw our gaze back to the most significant property of organic forms, which is that of making manifest, in the language of the senses, the peculiar nature of individual living beings and to bring, of this nature, direct testimony in their particular shapes" [2] (Fig. 6).

Therefore, if in the forms and functionality of the organic architecture in the village buildings we can recognize their openness towards the search for relationships with the surrounding nature, we can also realize that the use of colors is the tool that allows all of this to be achieved. In fact, colors are the symbolic and symbiotic presence, the vital expression of the natural environment of this territory and, at the same

Fig. 5 Red Lily.

Fig. 6 Rosehip.

time, as suggested by Portmann, they are the elements that can make the buildings of the Gellner Village more organic and therefore more expressive.

3. An Applied Study: The *Ribalta* Gellner, a Flip-Open Table

La *Ribalta* comes to life from the same process, that is by having a direct experience of the place, living and observing it, identifying with it.

Following up the constant jump in scale between the details and the general, the interior and the exterior, that characterize Gellner's work, I imagined the design of a removable and foldable flip-open table to be positioned on the wooden planks that make up the parapet of the livable balcony of which each cottage in the ENI Village has (Fig. 7).

I thought of a 60/80 cm square functional modules with a thickness of about 2.5 cm. Normally every accessory that is used in the house must then be stored somewhere. To combine this, and overcome possible space problem and of course because of the aesthetic aspect of images, I thought the flip-open table should also have the function of furnishing the house as if it were a painting. In fact, the images created for the artistic project are inserted on the surface of the *Ribalta*, which here transfer Gellner's thought into everyday objects. Once it has been used the flip-open table can be repositioned on the internal walls of the house, just like a work of art.

The image must have a very high print quality to justify its double use as a furniture and as an object for the home. The surface must be transparent, waterproof and resistant to use and time, easy to clean, easy to install on the terrace and easy to store at home.

It was therefore necessary to find a simple and elegant solution to hook the flap to the balcony planks so that the mechanism was hidden.

Furthermore, the same mechanism must have been used to hang the flap on the lodgings applied to the walls of the cottage (if not positioned too high, the flap could serve as a support surface, or shelf inside the house) (Fig. 8).

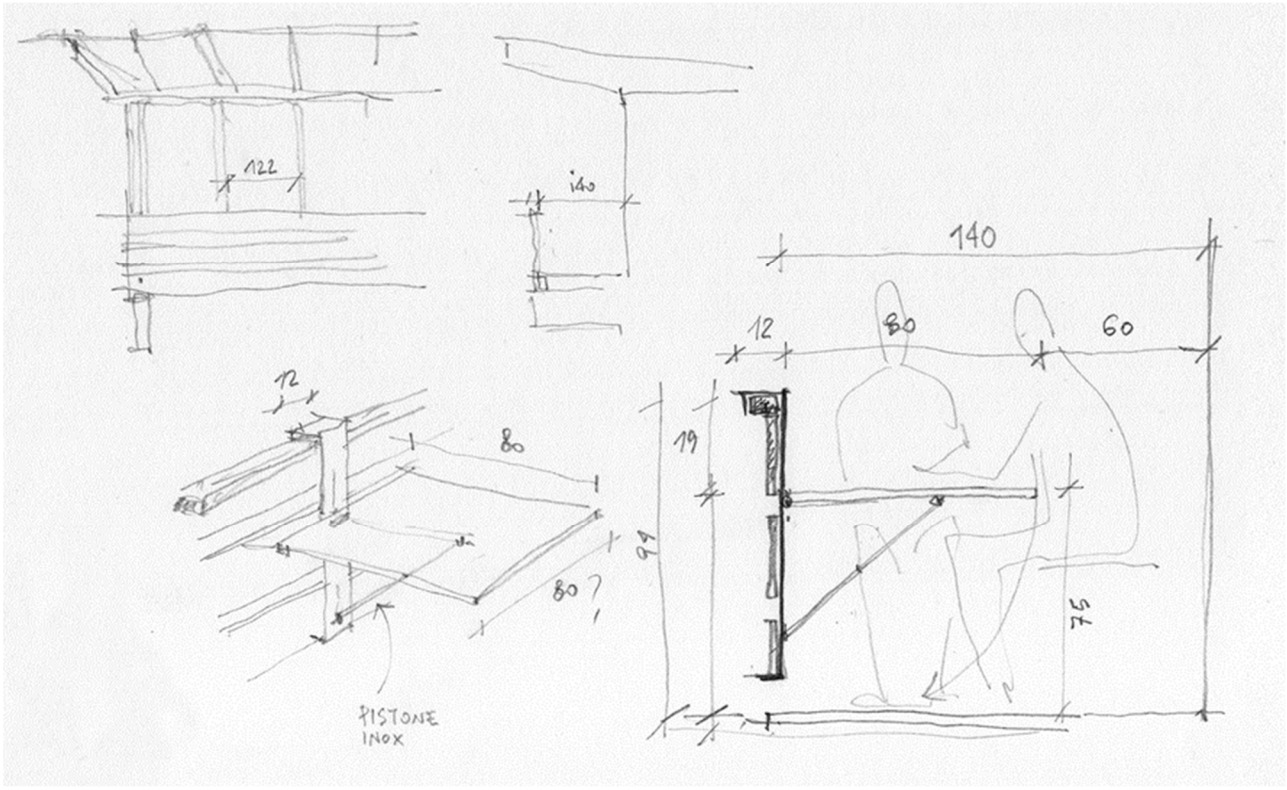

Fig. 7 Measures and possible solutions for the installation of the *Ribalta* in the balcony. Drawing by Arch. Edoardo Turozzi.

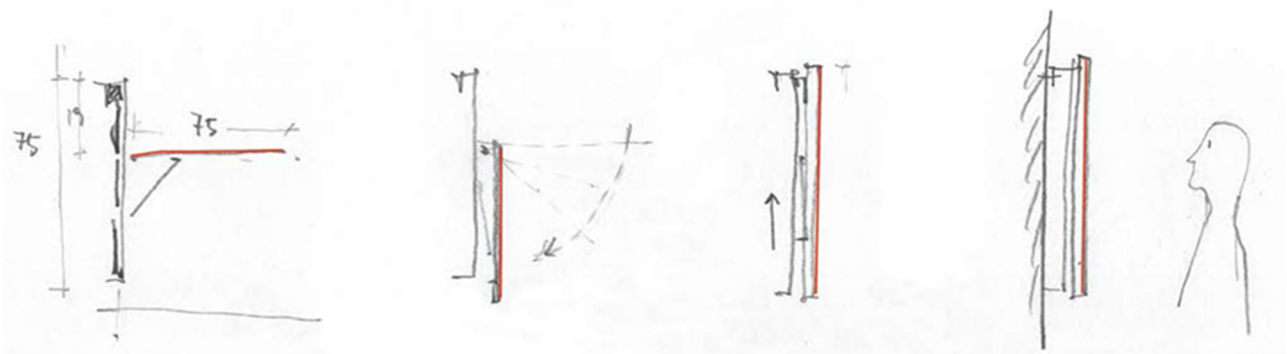

Fig. 8 The *Ribalta* in its two locations: positioned in the balcony and hanging on a wall. Drawing by Arch. Edoardo Turozzi.

4. Conclusions

As part of *Progettoborca*, other authors and artists approached Gellner's chromatisms.

Rob van den Berg worked between 2015 and 2019, creating with his artistic practice a visual translation of the aesthetics and method that Gellner adopted in the former ENI village. In the children's camp building, van den Berg collected the fallen plaster, found an old paper and with the "mould and deckle" technique and, through the use of a loom, he (re)created a brand new paper. The measurements of the sheets correspond to those of the square windows that give rhythm to the space of the buildings: by means of this project, that owns a regenerative matrix, the artist wants to underline the continuous dialogue of the village with the environmental context. Ilaria Fasoli (Iuav, Venice), attending a workshop curated by Marta Allegri and sponsored by the Academy of Fine Arts of Venice in 2015, describes her project as follows: "Behind the dormitory complex, in the western area of the children's camp building, a particular color of the plasters in shades of yellow and

pink catch the eye, shaping the idea of a photographic observatory. That is the approach photography entertains with nature and architecture, it allows you to document, know, understand. On the sides of the steps that lead to the dormitory there is also a luxuriant flora of mosses, lichens and *Carlina* flowers; the intent is to expand and accentuate the growth of the local flower, treating it as its own, personal and intimate garden." In her words the exploratory-cognitive role that photography plays is evident.

In 2017, during the "Abitare Condiviso" seminar, an activity promoted by the University of Padua and curated by Professor Edoardo Narne, around forty students were accompanied by teachers, tutors and a carpenter, in a process of active experimentation through which they conceived, developed and finally created, versatile prototypes of seats and furnishings and Magic Boxes—on a 1:1 scale which also adopt the colors present in the village.

Valeria Pin and Sebastiano Pallavisini in 2023 also used peeled plaster to produce wax crayons with which, together with self-produced charcoal, they drew cave paintings on the roofs of the children's camp buildings. In the same year Sara Magni, a student of the Bologna Academy of Fine Arts collects and catalogs Gellner's pigments and dyes some weaving threads.

All these art projects are regenerative and the regeneration they aim, in almost all cases, is pushed by the use of colors Gellner made. Thus, up until now, there had been no photographic research that studied and closely related the natural environment with the chromatic one created by Gellner. This project is born from a direct experience that, enriched with theoretic thoughts, gives rise to a new photographic aesthetic of the former ENI village. My work has always focused on giving art a sort of utility. In fact, to me, the applied study is the most important aspect of this research. The flip-open table combines both the artistic research with an object that approaches Gellner's creative thinking. Functionality, symbiosis with nature, places experience, research of quality and care are all ingredients present in the design and construction of the village which have been borrowed from me and from other artist involved in Gellner's chromatisms. La *Ribalta* also aligns perfectly with the ongoing regeneration activity carried out by *Dolomiti Contemporanee* and, compared to other research carried out in this sense, it is designed exclusively to add functionality to the use of the cottages of the former ENI village.

Acknowledgments

I would like to thank Arch. Gianluca D'Incà Levis founder and director of *Dolomiti Contemporanee* and *Progettoborca* for his great support in this project; Edoardo Turozzi for his help and participation and with whom I developed the *Ribalta*; Roberto Menardi and Raffaella Dibona, Department of Land, Environment, Agriculture and Forestry in San Vito di Cadore (Padua University), for their help in cataloging plants; *Minoter S.p.a* owner of the former ENI Village for his kind hospitality.

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Journal of Civil Engineering and Architecture
Volume 17, Number 11, November 2023
David Publishing Company
3 Germay Dr., Unit 4 #4651, Wilmington DE 19804, USA
Tel: 1-323-984-7526; Fax: 1-323-984-7374
http://www.davidpublisher.com, www.davidpublisher.org
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ISSN 1934-7359
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