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TECHNICAL ADAPTATION OF BUILDINGS TO THE CONTEMPORARY AGE OR A NEW LAYER OF HISTORICAL FABRIC. ELEVATOR IN HISTORIC FACILITIES

TECHNICZNE DOSTOSOWANIE BUDYNKÓW DO WSPÓŁCZESNOŚCI CZY NOWA WARSTWA TKANKI HISTORYCZNEJ. WINDA W OBIEKTACH ZABYTKOWYCH

Abstract

During use, architecture needs constant changes for maintenance and current needs. The article discusses implementing passenger elevators in historic facilities, using the example of installing an external elevator in the Baroque Bishop's Palace in Nysa. Adapting historic facilities for people with special needs requires combining aesthetics and functionality with technical requirements or conservation guidelines. The approach presented aims to discuss the heritage form without imitating historical forms, respecting the monument and complementing the existing structure for new functional use.

Keywords: accessible architecture, elevator, heritage, monument, public facilities

Streszczenie

Architektura podczas użytkowania wymaga ciągłych zmian związanych zarówno z konserwacją, jak i bieżącymi potrzebami. W artykule omówiono problem realizacji dźwigów osobowych w obiektach zabytkowych na przykładzie instalacji windy zewnętrznej na dziedzińcu barokowego pałacu biskupiego w Nysie. Dostosowanie obiektów zabytkowych do potrzeb osób ze specjalnymi potrzebami wymaga połączenia estetyki i funkcjonalności z wymogami technicznymi lub wytycznymi konserwatorskimi. Przedstawione podejście ma na celu omówienie formy zabytkowej bez naśladowania form historycznych, z poszanowaniem zabytku i uzupełnieniem istniejącej struktury dla realizacji nowych funkcji.

Słowa kluczowe: architektura dostępna, winda, dziedzictwo, zabytek, obiekty użyteczności publicznej

1. INTRODUCTION

Adapting historic buildings to modern occupancy standards is a challenge that requires a delicate balance between preserving historic value and introducing modern amenities. One of

the critical elements of modernizing historic buildings is ensuring accessibility, which often involves installing external passenger elevators in the absence of any other option. While elevators in a building's equipment improve functionality and accessibility, they must also, in the case of historic facilities, meet the requirements of protecting the preserved or restored historic fabric.

The problem of accessibility to historic buildings and public facilities has only recently been recognised in global activities, as evidenced, for example, by the implementation of the Interreg III ALCOTRA Italia – Francia RITT Réseaux d'Itinéraires Touristiques Transfrontaliers program on the French-Italian border to develop tourism in the Aosta Valley and Haute-Savoie regions and increase the mobility of tourists and the accessibility of historic facilities to the region's most important sites. The search for formal solutions that, on the one hand, interfere as little as possible with the historical fabric and silhouette of historic complexes, on the other hand, provide logical, functional and technical solutions, has become an essential part of the process of adapting historic facilities to the changing needs of modern tourism.

1.1. MATERIALS AND METHODS

The study covered five examples of adaptation and renovation of public utility buildings in Europe: Spain, Switzerland, and Austria, and 2 case studies in Poland.

The primary criteria for the selection of examples for analysis were:

- location in Europe,
- use of a historical building for public purposes (i.e., those related to administrative services, culture or education), as the one requiring the broadest range of accessibility regulated by law,
- accessibility was ensured by adding an external vertical communication (elevator),
- characteristic layout of the plan of historical buildings (buildings with internal courtyards),
- democratisation of access to historical elite objects, castles or palaces.

The research used a mixed method approach – a multiple case study and qualitative research. The adopted research method was divided into several stages. Firstly, a semi-structured literature review was performed. A protocol for this study was developed based on the preferred reporting items for the systematic review and meta-analysis (PRISMA) protocol guidelines.¹ The literature databases used for the review were Web of Science Core Collection, Google Scholar, and an Artificial Intelligence Research Assistant (Elicit.org and Scite.ai).

The analysis was limited to studies, the full text of which is available, written in English, and published in peer-reviewed academic journals. To identify and preselect the papers for the review, the following keywords were used: 'heritage', 'lift', and 'accessibility'. The research was limited to Europe as an area of specific approach to conservation doctrines and introducing the Accessibility Act (in Poland in 2019).²

For the initial search in databases, only 14 records were listed. This indicates the presence of a research niche, which this study aims, at least in part, to fill.

¹ L. Shamseer et al., *Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation*, "BMJ" 2015, no. 349, art. no. g7647.

² Ustawa z dnia 19 lipca 2019 r. o zapewnianiu dostępności osobom ze szczególnymi potrzebami [Act of 19 July 2019 on ensuring accessibility for people with special needs] (Dz.U. 2019 poz. 1696, Dz.U. 2022 poz. 2240).

The central part of the research on the accessibility of historical buildings obtained through an elevator was a multiple case study analysis, including a comparative analysis of architectural solutions based on data acquired from design studios, investors, and professional portals. Conceptual and competition designs were excluded from the study. The analysed examples have only been described so far in the professional press; hence, the sources have mainly focused on defining the individual facilities' technical parameters and architectural solutions.

1.2. LITERATURE REVIEW

The literature analysis revealed a small amount of research on ensuring vertical accessibility in historic facilities intended for public functions. The quantitative analysis of the researched articles, according to the adopted keywords and elimination criteria, showed the presence of only two publications that met the search criteria for the set keywords.³

The problem of ensuring vertical accessibility, with particular attention to wheelchair users in adapting historic buildings, has only recently resulted in the first cross-sectional publications in this area. Research has focused on diagnosing the problems that can arise in adapting historic buildings for accessibility and addressing accessibility in ways other than physical accessibility.⁴ There are also examples in the literature of case studies, implementations – interventions in the historical fabric or concepts for adapting individual monuments to ensure accessibility or just removing architectural barriers.⁵ The latter are by far the most numerous, although there was research in this group that also described solutions to the problem of adding elevators in historic facilities. This problem was widespread in the context of the adaptation of castles and fortresses of various types, principally due to the difficulties associated with the natural terrain on which such features were located.⁶

³ S. Lynch, D.G. Proverbs, *How adaption of historic listed buildings affords access*, “International Journal of Building Pathology and Adaptation” 2020, nr 4(38), pp. 589–605.

⁴ G.D. Bautista, J.C. Ripoll, *An Appeal for heritage interpretation and accessibility. Immersive and interactive virtual reality tours for mobile devices*, “Virtual Archaeology Review” 2013, no. 9(4), pp. 148–153. DOI: 10.4995/var.2013.4266; M. Puyueloa et al., *Experiencing augmented reality as an accessibility resource in the UNESCO Heritage Site called “La Lonja”, Valencia*, “Procedia Computer Science” 2013, no. 25, pp. 171–178. DOI: 10.1016/j.procs.2013.11.021; T. Nicolas et al., *Touching and interacting with inaccessible cultural heritage*, “Presence” 2015, no. 3(24), pp. 265–277. DOI: 10.1162/PRES_a_00233.

⁵ M.J. Rodríguez Pérez, J.G.G. Mosteiro, *De lo inexpugnable a lo accesible: correlación entre valores patrimoniales y turismo en los castillos de la Red de Paradores*, “e-rph” 2016, no. 19, pp. 22–53; T.B. Nulli, *The Verrès Castle Access Project*, “TeMA – Journal of Land Use, Mobility and Environment” 2010, no. 3(3), pp. 51–58. DOI: 10.6092/1970-9870/147; A. Naniopoulos, P. Tsalis, *A methodology for facing the accessibility of monuments developed and realised in Thessaloniki, Greece*, “Journal of Tourism Futures” 2015, no. 1(3), pp. 240–253. DOI: 10.1108/JTF-03-2015-0007; A. Naniopoulos et al., *Accessibility improvement interventions realised in Byzantine monuments of Thessaloniki, Greece*, “Journal of Tourism Futures” 2015, no. 1(3), pp. 254–268. DOI: 10.1108/JTF-03-2015-0008; J. Gil-Mastalerczyk, E. Gardyńska-Kieliś, *Accessibility study of historic buildings and contemporary heritage – on the example of Kielce’s public utility buildings*, “Structure and Environment” 2023, no. 15(3), pp. 133–146. DOI: 10.30540/sae-2023-012; D. Kuśnierz-Krupa, *Historical buildings and the issue of their accessibility for the disabled*, “IOP Conference Series: Materials Science and Engineering” 2019, no. 603(5), art. no. 052007. DOI: 10.1088/1757-899X/603/5/052007.

⁶ M.J. Rodríguez Pérez, J.G.G. Mosteiro, *op. cit.*; T.B. Nulli, *op. cit.*

A separate issue becomes an attempt to comprehensively address the issue of accessibility in historic facilities, valorise and create a catalogue of good practices in this regard, and determine the extent of interference with the historical fabric acceptable in terms of conservation.⁷ Only Salem Mokhtar Tarhuni's article directly touches on vertical accessibility for wheelchair users, but the main content of the article is an attempt to derive a typological breakdown of solutions implemented in historic facilities to ensure accessibility.⁸ It was divided into external or internal and considered very limited in use due to significant technical and aesthetic limitations. The proposed guidelines specified a significant impact on the building plan in the case of internal elevators, and a requirement that they be as transparent as possible and used in the case of expansions due to the significant interference with the form of the building being accessed.⁹

2. RELEVANCE AND CHALLENGES

2.1. PRESERVATION OF CULTURAL HERITAGE

Any interference with the structure of a historic building must be carried out with the utmost care so as not to damage the authenticity of the fabric and overall historical value¹⁰. Landmark buildings are valuable witnesses of history and culture, often possessing unique architectural and artistic features. Installing an outdoor elevator requires detailed planning and cooperation with landmark preservationists, builders and installers to ensure a harmonious combination of historic buildings with the newly designed element.

2.2. IMPROVING ACCESSIBILITY

The introduction of elevators allows historic buildings to be fully used by a wider group of people, which aligns with modern accessibility standards and regulations. This is often implemented in great contradiction to the original function of facilities that were usually fortresses that were not conquered as in the case of castles, pointing to an interesting paradox of realising accessibility in once elite buildings.

2.3. TECHNICAL AND AESTHETIC ASPECTS

Designing and installing outdoor elevators in historic buildings involves many technical challenges. Correctly completing an inventory with surveying measurements and discernment of installation issues and ground conditions is essential when working on a landmark building.

⁷ B. Szmygin, *Dostępność architektoniczna obiektów zabytkowych dla osób ze szczególnymi potrzebami*, Narodowy Instytut Dziedzictwa, Wydawnictwo Politechniki Lubelskiej, Warszawa 2022; B. Szmygin, K. Jeżyńska, *Adaptation of historic buildings for disabled people*, UNINET: University Network for Cultural Heritage – Integrated Protection, Management and Use, 2018.

⁸ S.M. Tarhuni, *Vertical accessibility for wheelchair users at historic buildings*, "Eurasian Journal of Science and Engineering" 2024, no. 10(1), pp. 12–22. DOI: 10.23918/eajse.v10i1p2.

⁹ *Ibidem*, p. 18.

¹⁰ Ustawa z dnia 23 lipca 2003 r. o ochronie zabytków i opiece nad zabytkami [Act of 23 July 2003 on the protection and care of monuments] (Dz.U. 2003 no 162 poz. 1568).

At the same time, the elevator's appearance must match the historic building's style and character, which often requires the use of non-standard solutions and unusual building materials.

2.4. LEGAL REGULATIONS AND ADMINISTRATIVE PROCEDURES

The installation of elevators in historic facilities is subject to strict regulations. It requires obtaining the appropriate permits from preservation authorities and fulfilling many administrative formalities. The process can be time-consuming and requires careful design documentation, which is carried out in close contact with state authorities to protect historic buildings depending on national or local conditions, which vary from location to location.

3. CASE STUDIES

Examples of successful projects can serve as models and inspiration for future realisations, pointing to successful strategies for integrating new elements into a historic structure.

Six outdoor elevator realisations in historic facilities from the European area were selected for analysis:

- The Regional Museum in Nysa (Poland),
- Albertina Museum in Vienna (Austria),
- The Foksal House 13/15 in Warsaw (Poland),
- the castle in Nyon (Switzerland),
- the centre of the historic town of Gironella (Spain).¹¹

3.1. THE REGIONAL MUSEUM IN NYSA

The elevator at the Regional Museum in Nysa has been the subject of efforts by the administration, the building and local authorities for many years due to the lack of access to much of its collection. This museum in Nysa is housed in a Baroque palace built by Bishop Francis von Neuburg of Wroclaw in 1729. Initially, the building was the seat of the bishops of Breslau, and then it was handed over to secular authorities. The facility suffered severe damage during World War II and was not secured or rebuilt until after 1947. The building is near-square with sides of about 50m, with a rectangular inner courtyard measuring 29 by 22 m, connected to Biskupa Jarosław Street through a passageway. The three-story palace has no basement.¹²

The first project by Alina Banach was created in 2013, but it did not come to life. In 2019, another documentation contractor was selected. The k2w architekci studio completed, in consultation with the monument preservation authorities, the elevator's design, which included installing the device in the southwest corner of the courtyard. A platform was designed to connect the passenger lift with the historic building to minimise interference with the historic fabric. The elevator's façade was covered with stainless steel panels, which allowed for a mirror effect in which the landmark façade is viewed. This minimises the visibility of

¹¹ D. Santibañez, *New access to Gironella's historic center* [in:] ArchDaily, 2.11.2019, <https://www.archdaily.com/776902/new-access-to-gironellas-historic-center-carles-enrich> (access: 14.06.2024).

¹² S. Zawada, *Zabezpieczenie zabytkowego pałacu biskupiego w Nysie*, "Ochrona Zabytków" 1968, no. 2, pp. 50–54.

the elevator itself, which disappears, as it were, into the courtyard's interior. The project was not completed until 2023.

3.2. ALBERTINA MUSEUM IN VIENNA

A general renovation and expansion to adapt the historic building, built as the Palais Tarouca in 1742–1745, to the modern requirements for exhibition space was carried out between 1996 and 2003. This involved combining the results of two architectural competitions for the general concept and the entrance area of the museum building, respectively.¹³ Hans Hollein is the author of the design of the entrance zone with an outdoor elevator and café hidden under a distinctive suspended aluminium roof (the so-called *Soravia Wing*).¹⁴

The elevator is partially accessible from inside the building, directly from the entrance area on the first floor and the basement floor, allowing access, as an outdoor elevator, to the terrace level of the first floor. Made of steel construction, it has been encased in glass panels and, on the Albertinplatz side, obscured by a polished stone slab in black with the museum's name. Its entrance is covered by a modern roof with an irregular shape and a very dynamic form. The elevator dimensions are as follows: entrance width is 110 cm, and cabin dimensions are 200 x 110 cm.¹⁵

3.3. THE FOKSAL HOUSE 13/15 IN WARSAW

The elevator at 13 and 15 Foksal St. in Warsaw was designed to revitalise two tenement houses for residential purposes, expanding them and adding a two-level underground parking garage to be accessed between 2016 and 2020. The investor was Ghelamco GP5 Sp z o.o. Foksal S.K.A. and the project was designed by PROART Pracownia Architektoniczna – Konserwatorka and SUD Architectes.¹⁶ The tenement at 13 Foksal Street dates from 1899,¹⁷ while Foksal 15 – from 1895.¹⁸ Most likely, the author of both buildings was Artur Spitzbarth. In 1936, the Foksal 13 tenement house was renovated, designed by Zdzisław Mączyński for Jan Wedel. Then, a panoramic elevator was made, the shaft of which was used to make the building accessible to the public.¹⁹ Along the full height of the second – already modern shaft, added in a similar manner, a decoration was applied in the form of a drawing of windows along with an original detail on the glass, where the given part of the detail was replaced by the new elevator.

¹³ *Albertina (Gebäude)* [in:] Wien Geschichte Wiki, updated 23.11.2022, [https://www.geschichtewiki.wien.gv.at/Albertina_\(Geb%C3%A4ude\)](https://www.geschichtewiki.wien.gv.at/Albertina_(Geb%C3%A4ude)) (access: 14.06.2024); W. Koschatzky, A. Strobl, *Die Albertina in Wien*, Verlag, Salzburga 1969, p. 9.

¹⁴ *Albertina* [in:] Hans Hollein, <https://www.hollein.com/eng/Architecture/Nations/Austria/Albertina>, (access: 14.06.2024).

¹⁵ Reaching us [in:] The Albertina Museum Vienna, <https://www.albertina.at/en/visit/reaching-us/#-section-2> (access: 14.06.2024).

¹⁶ Renowacja Kamienic Foksal 13/15 Warszawa [in:] Modernizacja Roku, <https://www.modernizacjarku.org.pl/pl/edition/2262/object/2346/renowacja-kamienic-foksal-1315-warszawa> (access: 14.06.2024).

¹⁷ Foksal 13 [in:] Proart, <http://www.proart.waw.pl/projekty/foksal-13> (access: 14.06.2024).

¹⁸ Foksal 15 [in:] Proart, <http://www.proart.waw.pl/projekty/foksal-15> (access: 14.06.2024).

¹⁹ A. Sołomiewicz, *Rewitalizowane kamienice Foksal z kultową windą Wedla* [in:] Propertydesign.pl, 21.11.2019, https://www.propertydesign.pl/architektura/104/rewitalizowane_kamienice_foksal_z_kultowa_winda_wedla,26548.html (access: 14.06.2024).

3.4. NYON CASTLE

Nyon Castle is located on Lake Geneva. It was built as a defensive residence in the 12th century by the Cossonay-Prangins family. The Counts of Savoy acquired it in 1293, after which it was expanded by adding two towers on the lakeside and an inner courtyard. Between 1574 and 1583, the Bern authorities, known as the “Leurs Excellences,” carried out construction work, significantly changing the castle’s character and giving it its current appearance. After the revolution in Canton Vaud in 1798, the city of Nyon acquired the castle from the newly created Canton of Vaud in 1804. From 1832, the castle began to serve as a courthouse, city council, and prison; in 1888, it was the city museum. In 1947, the houses in front of the castle were demolished, creating a vast square and sharply changing the view opening.²⁰ With the introduction of the museum function came the need to make the facility more accessible. Commissioned by the municipality of Nyon, represented by Denis de Techtermann and Vincent Lieber, curator of the Castle Museum, architects from the Amsler & Delachaux studio Christophe Amsler, Bernard Boujol, Nicolas Delachaux, Denis Glatz and Jacques Suard developed a solution to provide vertical access to the historic complex. Preliminary research that preceded the substantial restoration was carried out between 1990 and 1998. Between 1999 and 2006, signatory construction work was carried out, focusing on its administrative function, which required accessibility that could include a large part (the south wing) of the castle. Research and work on the construction of the parking lot was carried out in 1995–2004 and 2005–2006, respectively. It was decided to build an underground parking lot equipped with two elevators, providing access both in the castle area and this part of the city.²¹

The glass-and-steel structure has been separated from the body of the castle, constituting, in landscape terms, freestanding elements-sculptures, also connected by glass footbridges to a level providing a fully accessible entrance to the main part of the facility. These shafts house the complete communication (and evacuation) risers from the three-level parking lot located on the slope on top of which Nyon Castle is located.

3.5. AN ELEVATOR IN THE HISTORIC CENTER OF THE TOWN OF GIRONELLA

Gironella is a town on the Llobregat River in Spain, and its historic centre is located on a cliff. The remains of a medieval castle, complete with walls, attract crowds of tourists despite the castle’s architectural inaccessibility to date. The elevation difference has also resulted in a lack of communication between the upper and lower parts of the town. The historic centre has become depopulated due to the lack of accessibility. Architects from Carles Enrich Studio, in cooperation with MASAad, took on the challenge of improving the accessibility of the historic part of the town. The facility was completed between 2013 and 2015. The elevator is located at a strategic point on Cal Metre Road, which in the past led to textile colonies.²²

The unusual enclosure of the shaft causes the facility to interact strongly with the urban context in which the elevator was located. The shaft made as a steel frame structure, offset

²⁰ V. Lieber, *Histoire/s du château de Nyon*, Musée historique et des porcelaines château de Nyon, Nyon 2011.

²¹ J.F. Cabestan, *Amsler & Delachaux, Suard rehabilitation du chateau Nyon, Suisse*, “AMC” 2007, no. 170, pp. 86–91.

²² Gironella’s new access. Gironella 2013–2015 [in:] Carles Enrich Studio, <https://carlesenrich.com/projects/gironellas-new-access/> (access: 14.06.2024).

from both the stone slope and the wall protecting the crown of the cliff in the lower part remained only glazed, while in the upper part – additionally obscured by an openwork wall made of cavity bricks, perforated, which constitutes the shaft's enclosure from the outside. The exit on the upper level was again “opened” in terms of view thanks to a glass-only covering. This causes the adopted form to remain read as entirely contemporary on the one hand and, on the other hand, to complement the historical fabric, fitting seamlessly, both in form and proportions, into the traditional form of Gironelli architecture and alluding to the tower facility located in the line of the wall slightly to the east of the elevator location.

4. GOOD PRACTISE

Solutions not duplicating historical layouts, applied to historic facilities, are becoming an increasingly popular strategy for ensuring vertical facility accessibility. The analysed examples allowed us to identify a catalogue of good practices in this field, highlighting the authenticity of the historical substance and the distinctiveness of modern elements and reconciling them with contemporary needs to ensure access and adaptation to modern needs.

First and foremost, among these, is the use of innovative technologies and materials. Integrating elevators into historic tissues using modern technologies and materials can be significantly facilitated. Such solutions, such as elevators with glass walls or lightweight steel structures, can be less intrusive while providing, at the same time, a backdrop to the historic fabric. The use of exterior lifts encased in reflective materials introduces an element of variability into the composition, resulting from the reflection of both permanent aspects of the surroundings and those dependent on climate and seasons (greenery, users, sky).

Even solutions that assume a reduced visual impact by making material solutions more consistent (non-conventional use of brick or stone) remain modern in their form. The lack of a historicising costume indicates a clear indication of the need to separate the new function, on the one hand, as an element essential for practical reasons, significantly changing the functioning of the historic facility, and on the other hand, clearly new and different in shape and purpose, and playing a subordinate role to the primary function of the facility.

At the same time, the creation of such extensions, leaving aside purely aesthetic issues, is now possible to implement thanks to the use of modern measurement and design techniques such as BIM modelling, 3D scanning and surveying, allowing interference with the historic fabric, while minimising any damage to the historical fabric of the monuments covered by the works.

5. SUMMARY

Due to the technological requirements for the potential introduction of significant perforations into the historic substance, when elevators are introduced in existing structures, the preferred solution is to attach them additively to the body of the building. This creates a new façade layer, added directly outside the historic structure (Nysa, Vienna, Nyon, Gironella) or partially recessed into the fabric of the building (Warsaw).

In the visual design of such extensions, various stylistic variants are adopted, ranging from those inscribing themselves in the layout and historical form, through those employing

retroversion, to those building forms in contrast or, on the contrary, mimetically, blending into the surroundings. At the same time, the introduction of elevators into historical facilities whose original function has changed, especially if it was initially a defensive function (as a rule, difficult to access), creates a surprising effect of unexpected openness of the structure.

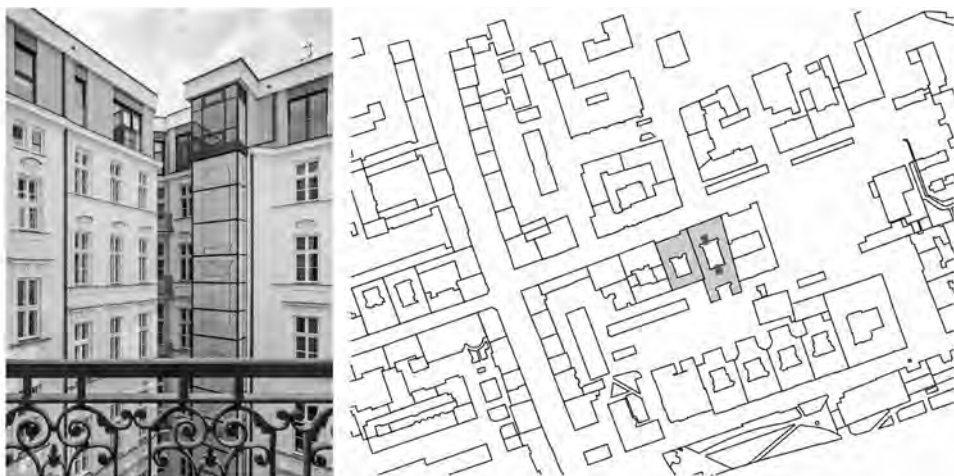
All the design approaches used in the analysed examples, whether additive or partially interfering with the structure of the monument, seek to improve the accessibility of the facility, enriching the historical fabric with another layer. It not only enhances the functionality and accessibility of the facility but also affects its aesthetic perception. Therefore, its implementation in a historical context should always be vigilant in responding to this context, proposing individualised solutions even with the typical “technical” fulfilment of the function itself.



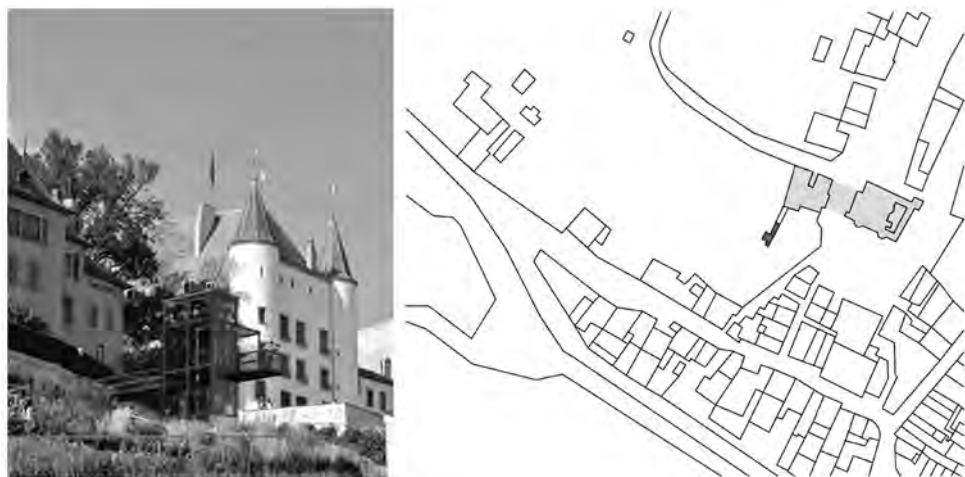
III. 1. View of the elevator (by Dawid Plachta) and a localisation scheme of the Museum in Nysa (authors' elaboration).



III. 2. View of the elevator (by Monika Adamska) and a localisation scheme of the Albertina Museum in Vienna (authors' elaboration).



III. 3. View of the elevator by Marcin Czechowicz, source: J.S. Majewski, *Dwie eklektyczne kamienice* [in:] *Architektura Murator*, 25.06.2020, <https://architektura.muratorplus.pl/biblioteka/dwie-eklektyczne-kamienice-aa-oU5v-a99E-jcvn.html> (access: 15.07.2024) and a localisation scheme of the Foksal 13/15 tenement house in Warsaw (authors' elaboration).



III. 4. View of the elevator, source: Château de Nyon / Musée historique [in:] search.ch, <https://search.ch/tel/nyon/place-du-chateau/chateau-de-nyon-musee-historique.fr.html> (access: 15.07.2024) and a localisation scheme of the Nyon castle (authors' elaboration)



Ill. 5. View of the elevator by D. Santibañez, *New access to Gironella's historic center* [in:] ArchDaily, 2.11.2019, <https://www.archdaily.com/776902/new-access-to-gironellas-historic-center-carles-enrich> (access: 14.06.2024) and a localisation scheme of the Gironelli Centre (authors' elaboration).

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