FUTURE-PROOF ADAPTATION METHODS OF POLISH W-70 LARGE PANEL RESIDENTIAL BUILDINGS

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ABSTRACT

The neglect and lack of recognition of post-WWII mass housing heritage within mainstream architectural practices have spurred an essential debate. This research paper addresses two interconnected issues: the absence of future-proof adaptation strategies for the Large Panel concrete system housing stock and the housing crisis in Poland. This study aims to provide an overview of future-proof adaptation methods aimed at improving living conditions in Poland's Large Panel concrete system buildings. The analysis encompasses technical and visual perspectives to establish guiding principles for the redesign and reuse. Specifically, the study explores the methods employed for future-proof adaptation of European estates built with prefab systems between 1960 and 1980. Additionally, the research investigates the limitations and possibilities of the W-70 building system, shedding light on its potential for adaptation and enhancement within the realms of the building envelope, structure, and public space domains. Situated within the scientific framework of adaptive reuse, this research contributes to the expanding knowledge base concerning strategies for transforming post-WWII mass housing stock into diverse, liveable, and inclusive neighbourhoods.

KEYWORDS: *Large Panel Concrete System, Adaptive Reuse, Future-proof adaptation, Modern Movement, post-WWII mass housing*

I. INTRODUCTION

1.1. Problem statement

Post-WWII mass housing districts represent a significant example of prefabrication on a large scale worldwide. The Large Panel concrete systems were initially implemented in over 70 countries to address the severe housing shortage caused by extensive urban destruction after the WWII (Alonso & Palmarola, 2019). In Poland approximately 50% of the housing stock was demolished in major cities (Piechotka, 2021). Moreover, the Communist Party, which controlled national urban planning and housing policies, fostered a culture of total standardisation between 1960 and 1989[1] (Plewako et al., 2007). Rapid industrialisation and subsequent urban migration further intensified the demand for new housing. Lack of market competition led to poor quality of produced building elements and their implementation with an underdeveloped and underinvested production base (Piechotka, 2021). These factors contributed to the widespread popularity of standardised solutions and the societal acceptance of significantly lower architectural quality, accommodating currently approximately 12 million Polish citizens (Trybuś, 2018).

The notable absence of comprehensive future-proof adaptation strategies and the disregard for disrepair are issues that mainstream architectural practices often overlook (Dragutinovic et al., 2017; Szafrańska, 2011; KIT, 2016). Although Large Panel blocks have become an integral part of the urban landscape, they face exclusion from preservation practices due to their perceived low heritage value and negative

[1] The standardisation of Large Panel concrete systems within the Polish building industry was initiated in the 1960s by the leading Communist party and persisted until the collapse and subsequent political transformation of 1989.

social perception[2]. However, these residential estates continue to play a crucial role in Poland by providing affordable rental or purchase prices. The prevailing housing crisis in Poland is primarily attributed to the scarcity of affordable new-build social housing (Trepka, 2021), given that privately owned housing constitutes over 84% of the total housing stock (Eurostat, 2021). Therefore, it is imperative to consider guidelines for improvement and reuse of the Large Panel blocks addressing current technical requirements, social changes, and economic targets (Szafrańska, 2011). This underscores the significance of these estates as part of the national heritage and emphasises the necessity for future-proof adaptation measures to extend their economic and service lifespan (Douglas, 2006). Furthermore, the urgent need for circular adaptations of outdated housing stock arises from the potential to minimise the use of new materials and reduce embedded greenhouse gas emissions. Notably, approximately 20-25% of the life cycle emissions of the current EU building stock are associated with building materials (EEA, 2022). Moreover, such guidelines could prevent critical challenges these estates face such as profit-driven densification approaches or top-down shortsighted transformations (Domschky et al., 2022, Aernouts et al., 2020).

1.2. Research question

This research offers an overview of a wide range of future-proof adaptation methods to improve the living conditions within the W-70 Large Panel concrete system buildings in Poland. The rationale for choosing this system lies in its significant representation, accounting for more than 40% of Poland's total Large Panel housing stock[3], and its open-structure nature[4] (Dzierżewicz, 2010). Moreover, the analysis from a technical and visual perspective suits as a guiding structure for setting the re-design principles. The following research question has been formulated to address the potentials and constraints: *What are the possible future-proof adaptation methods for the Polish W-70 Large Panel concrete system residential buildings?* Two sub-questions are formulated and categorised into analytical and technological domains to answer the main research question. 1) Analytical: *Which adaptation methods were used for the future-proof revitalisation of the estates built between 1960-1980 in Europe?* 2) Technological: *What are the limitations and possibilities of the W-70 building system?*

II. METHOD

2.1. Frame of Reference

The discourse surrounding the adaptation of Large Panel concrete system buildings encompasses various publications, experiences, and perspectives stemming from diverse social, cultural, political, and economic contexts. Approaches to adaptation span from extensive transformations such as demolition and replacement (e.g., Bijlmermeer estate in The Netherlands) to provisional refurbishments and energy retrofits (e.g., Bolesława Chrobrego estate in Poland). Given the multifaceted nature of this topic, this research paper will focus on two key domains. Understanding the social dynamics and layers associated with these estates is essential for ensuring their continuity, making it a key objective and primary catalyst for change. Therefore, it is crucial to recognise that these estates should not be regarded as closed systems of a bygone era but as *open systems of the present*, confronting stagnation and neglect (Dragutinovic & Nikezic, 2020).

Moreover, given the multifaceted nature of building adaptation, various terminologies have been employed in literature and practical contexts. Within the academic discourse on adaptive reuse, there

[2] In public opinion, the prefab block estate symbolises the ubiquitous dullness and attempts to enslave people by the political system (Alonso & Pedro, 2019; Trybuś, 2018). Consequently, as in other post-Soviet countries, this questionable architectural style has become firmly established in the Polish language, receiving its terms such as *"Wielka Płyta"* (literal translation of the "Large Panel"), *"Blok"* or *"Blokowisko"* (pejorative exaggeration of the block term regarding the scale of the estates).
[3] This value includes the other system, Wk-70, as the chosen W-70 system is its predecessor. They exhibit similar system-driven characteristics such as loadbearing capacity, dimensions, materials, and structural joints, thus both systems can be considered as the subject of this study.
[4] The Large Panel prefabricated concrete building systems in Poland were developed based on central and regional typification, with closed systems (loadbearing façade) such as WWP or OWT, or open systems (non-loadbearing façade), for example, W-70 and Wk-70 (Piechotka et al., 1974).

are multiple ways of dealing with existing buildings. One of the definitions is tagged by their structural characteristics ranging from conservation and restoration methods towards conversion or retrofitting, as introduced by Liam Wong in *Adaptive Reuse* (2017: 13-28) or in the seminal book *Building Adaptation* by James Douglas (2015). Therefore, there is a need to establish a definition framework for building adaptation projects. The level of impact on the existing building can categorise those methods. Moreover, Sheida Shahi (2020) developed a Definition Framework for Determining the Scope of Building Adaptation Projects (Figure 1a). The authors studied primary academic literature focusing on Building Adaptation terminology and established a summary focusing on building refurbishment, rehabilitation, retrofitting, renovation, adaptive reuse, building conversion, and material reuse. Those terminologies will be used for further analysis framework of adaptation methods.

Lastly, the technology domain will be addressed by analysing the existing building's structure by the shearing layers concept (Figure 2b) developed by Frank Duffy and further elaborated by Steward Brand (1994). Following the authors' argumentation, buildings are not homogeneous. In contrast, they have dynamic layers of diverse lifecycles, where the building's site or structure have the lowest rate of change and the interior layout or interior equipment the highest. While planning for renovations, it is essential to identify the condition of these layers, to effectively plan and carry out maintenance, repair and demolition tasks.

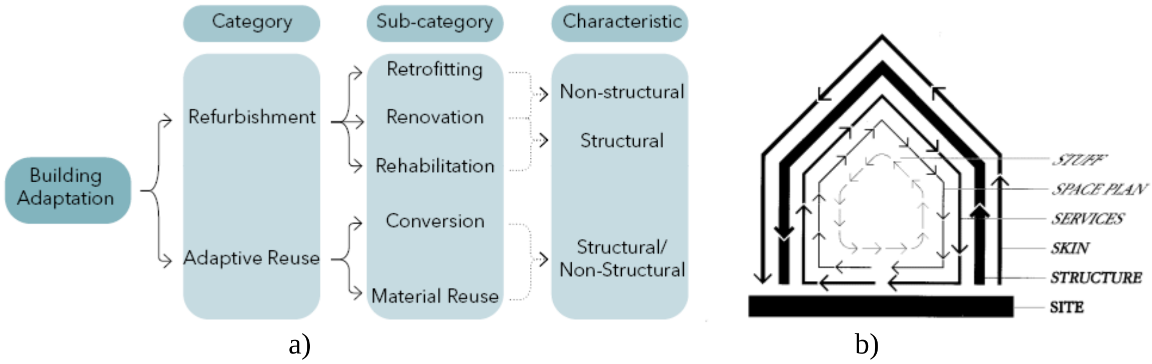

Figure 1. From left: a) Definition Framework for Determining the Scope of Building Adaptation Projects (Shahi et al., 2020), b) A Building's Shearing Layers (Brand, 1994).

2.2. Method

This study's primary and secondary sources informed the research on the possibilities for future-proof adaptation strategies in the context of Large Panel W-70 settlements in Poland, drawing upon knowledge from urban renewal practices in several European countries. Two primary sources were utilised: the case study and the W-70 system analysis. The secondary sources included literature and article reviews, official documents from the relevant housing associations, and online media (websites, articles, and films).

Analytical study

The scope of the chosen case studies is determined through preliminary research and evaluation of their relevance, focusing on examining adaptation methods that exhibit technical, architectural, or conceptual transferability to the Polish context. The selection criteria for these case studies include the period of construction (the 1960s-1980s), technical aspects (utilisation of the Large Panel system), geography (Central and Northern Europe), accessibility (well-documented examples). To gather relevant information, the research involves an extensive literature study encompassing academic resources and publications by public bodies. Online media sources, such as websites, articles, and other online content, are also consulted to supplement the research findings.

Technological study

The methodology employed in this study involves the analysis of various elements of the W-70 system to address specific research questions related to its design principles, construction techniques, structural performance, and limitations. The elements of the W-70 system, are quantitatively studied to understand their characteristics and properties. Normative books are studied to gain insights into the system's design principles. Technical problems associated with the W-70 system are addressed through a literature review on structural analysis. By employing these methods, the study aims to understand the elements comprising the W-70 system comprehensively, analyse its structural limitations, and identify elements that can be transformed.

III. ADAPTATION METHODS OF THE POST-WWII HOUSING ESTATES

3.1. Overview

During the initial phase of the analytical investigation, an examination was carried out on diverse instances of Large Panel housing adaptations in Europe built between 1960 and 1980. The research centered on examining specific instances from The Netherlands, France, Germany, Finland, and Slovakia (Figure 2).

Nb	Building	Estate	City	Country
B1	Kleiburg	Bijlmermeer	Amsterdam	Netherlands
B2	G, H, I	Grand Parc	Bordeaux	France
B3	Bremer Punkt	Gartenstadt Sud	Bremen	Germany
B4	Rakuunantie 1	Vanha Munkkiniemi	Helsinki	Finland
B5	Dobšinského 1095/40	P. Dobšinského	Rimavska Sobota	Slovakia
B6	Chrobrego 25-27	Bolesława Chrobrego	Poznań	Poland
B7	Forsythenstraße 3-13	Krautersiedlung	Dresden-Gorbitz Ost	Germany
B8	Wilhelmsruher Damm	Märkisches Viertel	Berlin	Germany

Figure 2. Scope of case studies.

3.2. Building Envelope

One method for addressing the building's envelope adaptation is focusing on energy retrofit challenges (Figure 3a). The Large Panel concrete system buildings often face issues related to outdated regulations, poorly insulated facades, permeable windows, and inefficient heating systems. Consequently, energy retrofitting efforts prioritise enhancing the insulation capacity of the building's external envelope and improving the interior comfort. An illustrative example of this approach is the modernisation project undertaken in Märkisches Viertel, where the facades were insulated using an Exterior Insulation and Finish System (EIFS) composite façade panels (Appendix 4B8). This retrofitting measure resulted in a neutral energy balance (GESOBAU AG, 2009).

On the other hand, adapting the external envelope can also improve or alter architectural qualities such as visual appearance and individual expression. The case studies from Poznań and Rimavska Sobota (see Appendix 2B4 and 3B5) achieved it by façade transformation and refurbishment of the balconies (Figure 3b). The instance in Poland demonstrates resident involvement in the adaptation process, and the resultant personalised architectural expression[5]. Furthermore, in each examined instance, the visual aspect played a pivotal role in enhancing the perceived value of the adapted structure for the residents.

[5] The balcony art serves as a reference to the Polish artist Ryszard Winiarski. Each resident employed the identical method of casting a die, thus yielding a distinctive pattern for individual balconies.

In the case of Vanha Munkkiniemi, a distinct approach was employed, which entailed the demolition of all components except the load-bearing structure and the inner shell of the concrete walls (see Appendix 2B3). The replaced elements, including concrete exterior panels, windows, and fastening structures, were substituted with a new facade constructed using wood-based materials (Metsa Wood, 2016). Unlike the examples observed in Germany, Poland, and Slovakia, introducing new foundations was necessary for the non-loadbearing light frame wood elements attached to the remaining concrete structure (Ibid.). Achieving a high level of air-tightness within the external envelope involved insulating window and door openings against the concrete wall, utilising adhesive fabric as an air and vapour barrier. Consequently, insulation was not required between the existing structure and the newly installed element, except for implementing fire protection measures on each floor.

Another approach for enhancing multi-level buildings is the implementation of a Facade Extension (Figure 3d). This strategy was employed in the Grand Parc adaptation (see Appendix 1B2), where three 10-15 storey buildings underwent renovation by adding self-supporting steel frames and new balconies designed as winter gardens (Publica, 2017). As a result, energy balance, aesthetic expression, interior climate, and spatial functionality were achieved. Notably, the construction process for this project was relatively brief, taking approximately 12-16 days to complete. Unlike a similar renovation endeavour in Finland (see Appendix 2B3), where residents were required to vacate their premises for a duration of six to twelve months during the technical refurbishment (Mustonen in Harnack Ed. et al., 2020), the residents of Grand Parc were able to remain in their homes during the construction period. This expedited construction timeline was made possible by focusing solely on improving the external envelope of the building. The use of prefabricated modular components, securely attached to the existing structure, along with precast structural concrete slabs and columns, contributed to the efficiency of the process (Publica, 2017).

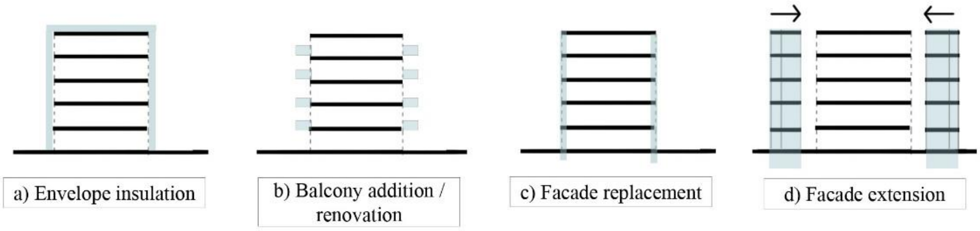

Figure 3. Adaptation Methods Influencing the Building Envelope.

3.3. Building structure

The housing developments that emerged in the 1960-1980s were characterized by highly efficient design principles, specifically tailored for nuclear family profiles. As a consequence, the apartment sizes remained consistently small, lacking diversity and failing to meet the needs of different social layers. Consequently, in several examined cases, alterations were made to the layouts of these apartments (see Figure 4a), as seen in examples such as Kleiburg, Panelak, and Krautersiedlung. In the Slovakian case (see Appendix 2B4), the layout of the building underwent a significant transformation, reducing the number of apartments from 8 to 2-6, ultimately resulting in a 40% reduction in the total number of dwellings within the structure. Creating more spacious housing units at a lower density was a recurring theme observed across other examples studied.

The Selective Demolition (Figure 4b) strategy was predominantly observed in the German and Dutch case studies, namely Dresden-Gorbitz and Amsterdam-Bijlmermeer (see Appendix 4B7). This approach was adopted in response to the high vacancy rates. Selective Demolition involved partially dismantling prefab buildings to introduce elements of identity within monotonous structures, establishing a human scale where the blocks exceeded four levels, and incorporating a mixed housing typology, such as penthouses with rooftop terraces. The Krautersiedlung adaptation is an illustrative example where a combination of demolition and comprehensive transformation were employed (KIT, 2016). Throughout the transformation process, the height of the buildings was reduced by 50%, and the prefabricated structures were disassembled at the joints of the panel modules. This practice resulted in a new housing typology, wherein eight-storey monotonous blocks were replaced by low-rise, three- to four-floor apartment buildings featuring balconies and rooftop gardens (Ibid.). Implementing the Selective Demolition method enhanced qualities in layout, proportions, and aesthetics, ultimately significantly reducing the vacancy rate to just 6% in 5 years from the start of the transformation (Ibid.).

Furthermore, an alternative approach was employed in the Greater Helsinki Region, encompassing Helsinki, Espoo, and Vantaa, where specific housing associations financed repairs by constructing one or two other stories atop existing buildings (Figure 4c). In the studied example from Helsinki shown in Appendix 2B3, the process involved the removal of the old roof and addition of timber-based housing units (Metsa Wood, 2016). Moreover, constructing the new exterior walls entailed using lightweight wooden elements as non-load-bearing structures. Unlike the French construction method, this example relied on locally sourced sustainable materials.

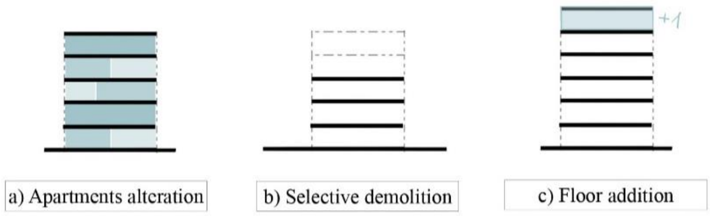

Figure 4. Adaptation Methods Influencing the Building Structure.

3.4. Public Space

The infill development strategy is exemplified by the Bremer Punkt project, a modular and prefabricated hybrid structure implemented in Bremen, Germany, in the districts of Neustadt, Kattentum, and Schwachhausen, which were constructed between the 1950s and 1970s (Klepel in Harnack Ed. et al., 2020). Serving as a prototype for other areas, the project offers serial diversity, providing contemporary, affordable, and flexible housing options for diverse resident groups. The housing units within this system offer over 60 different layouts, ranging from compact 30 m2 one-room apartments to spacious 138 m2 six-room apartments (Ibid.).

Moreover, activating the plinth and creating safe and diverse spaces around the building were primarily achieved through ground floor extension or alteration (see Figure 5b, c). A notable instance of this approach can be observed in the adaptation of Kleiburg in Bijlmermeer, as depicted in Appendix 1B1. In this Dutch example, the entrances of the two preserved buildings (out of a total of 16, with the remaining 14 undergoing partial or complete demolition) were integrated, resulting in an enhanced sense of security and expanded passageways (NL Architects, 2016). Furthermore, the functional utilisation of these areas underwent a transformation, shifting from storage spaces to accommodate various residential, commercial, and collective purposes (Ibid.).

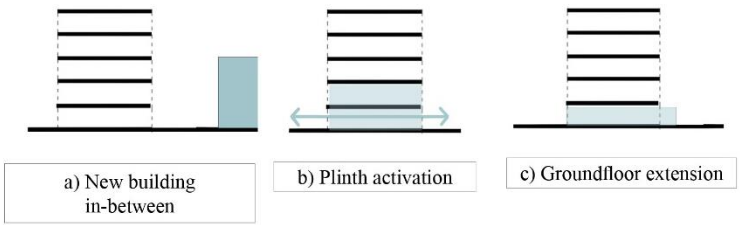

Figure 5. Adaptation Methods Influencing the Public Space.

IV. W-70 LARGE PANEL SYSTEM FLEXIBILITY

4.1. Overview

The advent of the W-70 system marked a significant national breakthrough in the approach to typification within the construction industry. Implementing open typification principles aimed to yield residential complexes with practical, functional solutions, reasonable spatial configurations, and individual architectural character (Piechotka, 2021). However, despite the architects' visionary intentions, the full potential of this state-wide initiative remains largely unrealised. The relentless housing crisis and the propagandistic objectives of the governing party have prioritised quantity over quality. Nevertheless, the modular and adaptable nature of the W-70 system offers prospects for further structural and non-structural adaptations within the system-driven limits.

4.2. The elements of the W-70 building system

The ordering principle of shearing layers allows for analysing W-70 buildings as a collection of elements with varying lifespans (Figure 7). It is essential to consider, that the Large Panel concrete system buildings were initially intended as temporary solutions with a predetermined structural lifespan of 50-70 years (Figure 6) (ITB Report, 2018). However, recent findings suggest that these estates can remain structurally sound for an additional 60-70 years, emphasising the need to develop strategies for their sustainable transformation[6] (Ibid.).

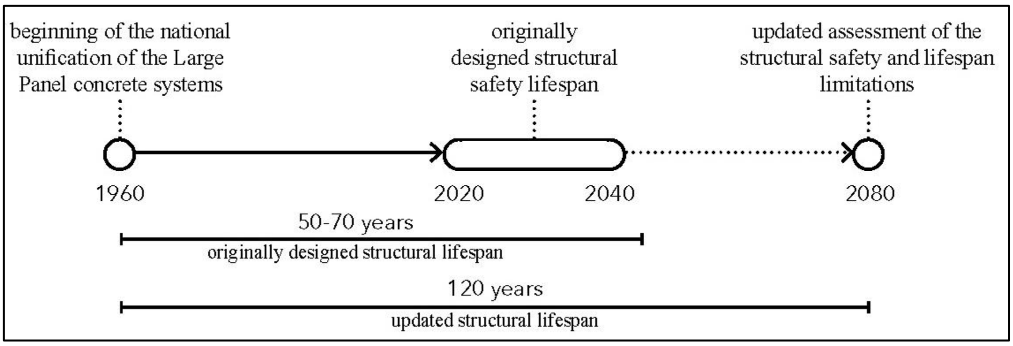

Figure 6. The structural lifespan of the Large Panel concrete system buildings.

[6] In response to the expiration of the originally intended 60-year lifespan of the Large Panel concrete structures, the Polish Ministry of Development and Technology conducted an extensive analysis between 2014 and 2018. For four years, they examined over 400 buildings constructed using various large-panel construction systems, including WUF-T, W-70/Wk-70, and Szczecin, in several districts across Poland.

The structural framework of W-70 buildings is supported by Large Panel concrete walls distributed perpendicularly, providing the necessary support for the floor slabs (Figure 9). The bearing walls are crucial in transferring vertical and horizontal forces to the ground. In the transverse system, the walls are supported by unidirectionally spanned floor slabs, which can be located in both directions due to the universal design of the vertical and horizontal joints (Wierzbicki et al., 2013). Stiffening walls, positioned in both axes of the building, provide stability and rigidity against horizontal forces (Figure 8). The floor slabs act as a rigid shield, stiffening the entire structure against wind forces through longitudinal joints, supports, and perimeter connections. All ceilings are integrated within a single storey, forming a monolithic surface capable of carrying horizontal or alternating loads (Piechotka et al., 1974). The walls are primarily constructed using concrete with a class of B20÷B30 and a thickness of 15cm (Wierzbicki et al., 2013). Reinforcement is included in the walls to counteract cracks resulting from concrete shrinkage, temperature changes, local stress concentrations, or potential damage during transportation and assembly. The skin facade of the building consists of non-loadbearing elements from cellular concrete panels (Figure 7e). These facade panels are connected using steel clamps, which are known to experience significant degradation issues (ITB, 2018).

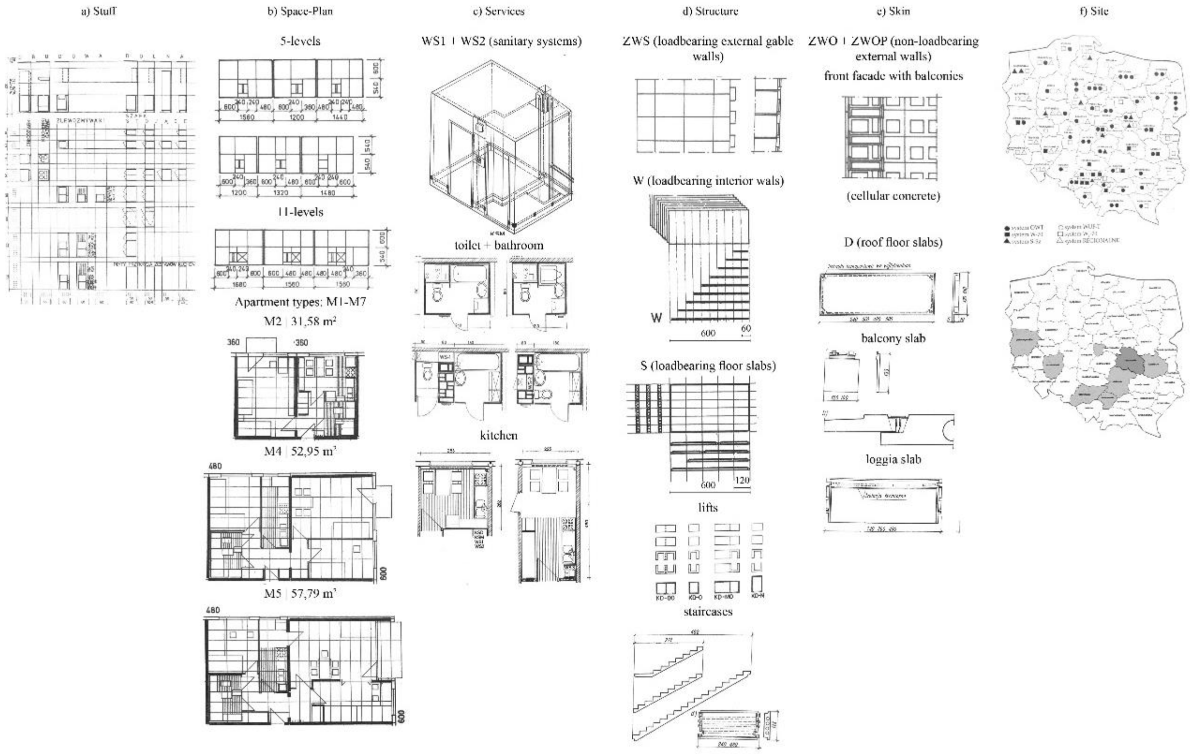

Figure 7. Overview of the W-70 system elements.

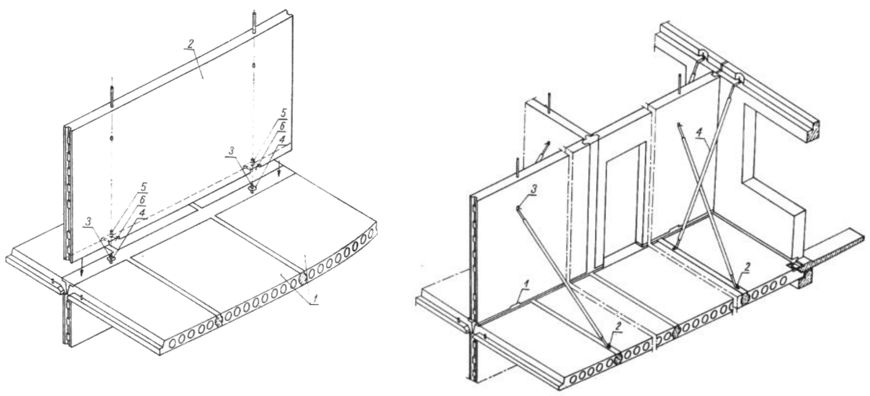

Figure 8, Construction process schemes of joining the Panel Wall with the Floor Slab (Piechotka et al., 1974)

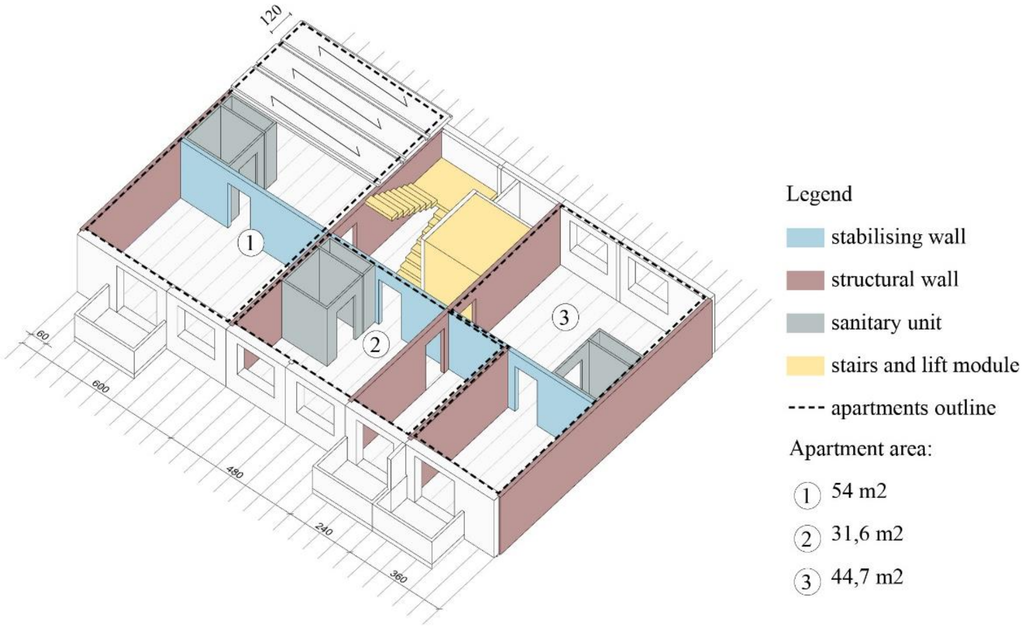

Figure 9. Example plan of one unit with three flats.

4.3. Possibilities and limitations

One of the significant possibilities lies within the inherent structural nature of the system. Specifically, the façade's horizontal joints bear most of the wind loads, providing continuous wrapping around the building (see Figure 10a). As a they do not have loadbearing function, they can be disassembled and reused, crushed, or transformed back into raw material (Concrete to Cement and Aggregates). The first approach has been extensively studied by dismantling buildings constructed in the 1960s in various European countries. For instance, the concrete panels were repurposed in Sweden to construct a new showcase pavilion (ReCreate, 2020). The second approach, commonly employed in The Netherlands, involves utilising crushed concrete to create new streets (Wassenberg, 2013). The third option (C2CA), involves the conversion of concrete waste into coarse and fine fractions, such as sand and hydrated cement materials, through a mobile recycling machine.

The evaluative assessment of the flexibility inherent in the Building Extensions method can be deduced by examining case study examples. Determining the ultimate limit state of the structure proves challenging due to variations in materials and the quality of construction work across different buildings. Nonetheless, estimation can be based on dimensional and analytical investigations of the system (see Figure 11b). The same structural elements were employed in typical 5- and 11-storey buildings. Moreover, instances exist of diverse 1-4 storey additions atop 5-8-storey Large Panel W-70 buildings in Warsaw (Knyziak, in Błaszczyński et al., 2017).

Furthermore, the potential demountability of the system presents an intriguing prospect, attributable to the modular characteristics of the 2D elements and spatial layouts (see Figure 10c). The development of the Wk-70 system involved close collaboration with the German Democratic Republic (DDR) between 1969 and 1975, coinciding with the implementation of the WBS-70 system (Kamińska, 2022). Considering that the Krautersiedlung in Dresden-Gorbitz was built in 1979-1989 with the WBS-70 system, there is a technology-based transferability to the Polish W-70/Wk-70. Therefore, notable similarities exist, including adopting a primary grid based on the 60x60cm module and the type of structural joint utilised. Consequently, the experiences from German examples provide a qualitative reference for structural transformations within Polish buildings. However, during such transformations, it is crucial to incorporate reinforcement measures, considering the shielding structure and stabilising function of the façade panels (see Figure 10d).

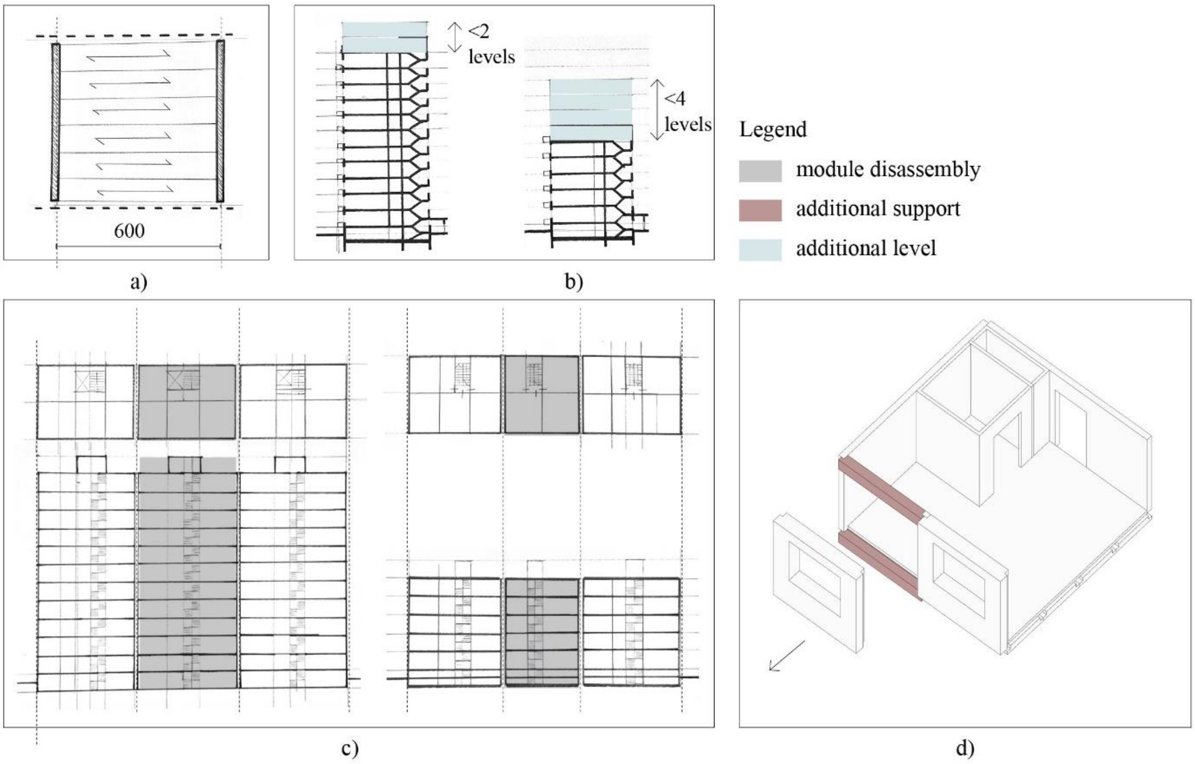

Figure 10. From left: a) Open-nature structure. Non-loadbearing facade., b) Schematic estimation of additional level, based on 11- (left) and 5-storey (right) typical W-70 buildings., c) Possibilities for module demountability., d) Need for structural reinforcement while demounting particular panels.

V. Conclusions

The future-proof adaptation of Large Panel estates in Poland requires a comprehensive approach that addresses social, economic, managerial, ecological, psychological, educational, financial, and other relevant factors. This includes addressing contextual challenges, employing future-proof methods, and considering system-specific structural limitations. By adopting such an approach, these estates' long-term sustainability and resilience can be ensured.

The range of adaptation methods and the scope of adaptation possibilities for W-70 buildings is limited by the structural system and socio-economic criteria. In the Polish practice, insulation improvement by adding layers is a common practice. However, it is not sufficient for a long-term strategy. Firstly, the interventions within the Building Envelope are the least impactful on the existing, including the residents and lack of relocation necessity, as it was inevitable in the studied examples of structure-related interventions. Removing the non-loadbearing, detachable elements and replacing them with new air-tight panels is an promising possibility, keeping in mind the stability of the structure and adding support if needed for the horizontal forces.

The addition of new structures is another solution that is feasible in the Polish context. The extension such as winter gardens should be limited by the sun orientation, the depth of the room and the distances to the surrounding built and natural environment. Separate foundations can be added to prevent structural overload or even support the existing structure. Consequently, the spatial, energetical and aesthetical values should be improved. Moreover, additional top levels are another example of a feasible solution to improve the architectural diversity and implement variety into the topologies of the residential offer. This strategy can be crucial for Polish neighbourhoods, as most of the large-housing estates are within the mixed ownership system run by a housing association[7]. Therefore, the investment stays within the neighbourhood, and new tenants increase the overall budget, making future investments within the estate possible. Therefore, the coordinated approach of the housing association and the

[7] In Polish *spółdzielnia mieszkaniowa* that can be related to the condominium system.

apartment owners is crucial for successful development, both in terms of investment and the participation of residents.

The primary benefit of a comprehensive renovation is that it can be done at once, and the inconvenience for the residents is minimised. On the other hand, such a renovation's drawback is the need for a significant budget and time. Selective Demolition practice was mainly used within the shrinking estates with the highest rates of social decay, crime or unemployment, but also related to the housing markets and oversupply - even in such tight markets as Amsterdam. It must be stressed that such measures, as in the Bijlmermeer example, are taken only as the last possible measure - they were preceded by 20 years of unsuccessful refurbishments. Nevertheless, the complete transformation took over a quarter of the century, and an enormous amount of money was not ultimately returned to the district. On the other hand, this method can also be implemented on a smaller scale, such as in German examples. However, the occupancy and ownership state is crucial here, as in Germany, the converted buildings were mostly vacant and entirely owned by a housing association. This situation is very different in Poland and can be compared to other post-Soviet countries (Slovakia, Czech Republic). Nevertheless, the approach to change the monumental blocks by Selective Demolition to implement the human scale and increase the social-economic values by diversifying the buildings might be a valuable solution for the future.

5.1. Relevance

The debate on the post-WWII heritage is crucial to face the negligence and lack of recognition within mainstream architectural practices. This research can add the Polish perspective and draw attention to the situation within the post-Soviet countries as another example. The Modern Movement DOCOMOMO International Mass Housing Archive or initiatives such as *"What interest do we take in Modern Movement today?"* (Dragutinovic & Nikezic, 2020) conduct an ongoing research towards this topic. Moreover, the relevance of studying the Large Panel systems today is tied not only to the adaptation of the outdated housing stock but also to current issues of reducing carbon emissions and contributing to global climate protection to achieve the sustainability goals of the EU until 2050. In the larger social framework, the research on future-proof adaptation strategies for post-WWII residential estates addresses the pressing need for affordable social housing. Within the scientific framework of adaptive reuse, this research contributes to the growing knowledge of strategies for transforming post-WWII housing stock into diverse, liveable, and inclusive neighbourhoods. As a result, the neglected yet ubiquitous housing stock can become architecture beyond political ideologies, trends or profit-driven market.

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LIST OF FIGURES

Appendix 1

DATA

Sequence number	B1
Location	Kleiburg, Netherlands
Net floor building area	6800 m2
Original number of apartments	13000
Apartments after renovation	6000 (-7000)
Developer's profile	Public (Nieuw Amsterdam)

Sequence number	B2
Location	Grand Parc, France
Net floor building area	44210 m2 (+23500 m2)
Original number of apartments	530 (G=80, H=225, I=225)
Apartments after renovation	530 (+8)
Developer's profile	Social housing (Aquitanis)

CONTEXT

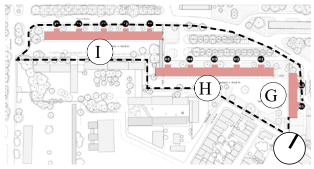
top view

site plan

renovation
Kleiburg
demolished

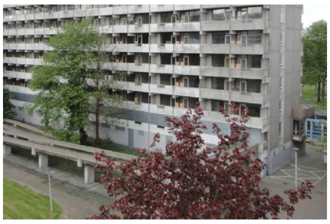
top view

site plan



renovated buildings
site, area= 2,375 ha

IMAGE



original, built 1965

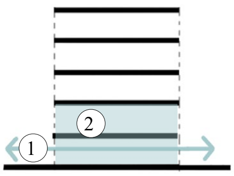
adapted 2012-2016

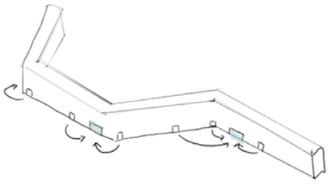
original, built 1950s

adapted 2016

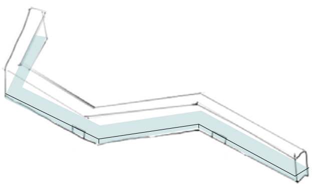
ADAPTATION METHODS

Plinth activation



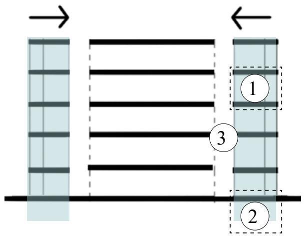


1 regrouping underpasses into larger openings

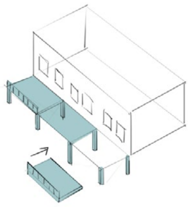


2 residential + work

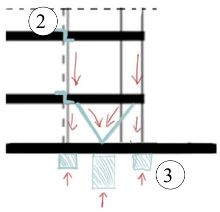
Facade extension



1 modular balcony / loggia



2 separate loadbearing structure
3 connection to existing floors

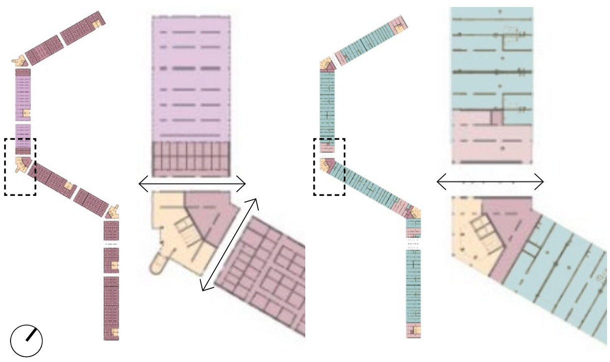


FLOORPLAN

replaced
added
storage
renovated
residential
circulation

before adaptation

after adaptation



SOURCES

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https://www.aquitanis.fr/

Appendix 2

DATA

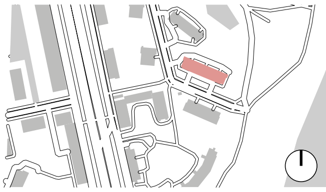
Sequence number	B3
Location	V. Munkkiniemi, Finland
Net floor building area	421 m2
Original number of apartments	-
Apartments after renovation	(+6)
Developer	Private (Asuntoverstas AF)

Sequence number	B4
Location	Rimavska Sobota, Slovakia
Building area	3775 m2
Original number of apartments	64
Apartments after renovation	42 (-18)
Developer	Private

CONTEXT

top view

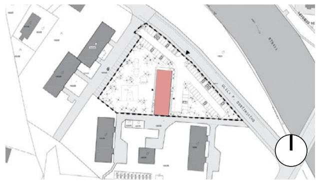
site plan



renovated building

top view

site plan



renovated building
site area

IMAGE

adapted 2019

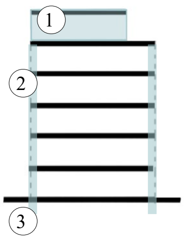
rooftop view

original, built 1960s

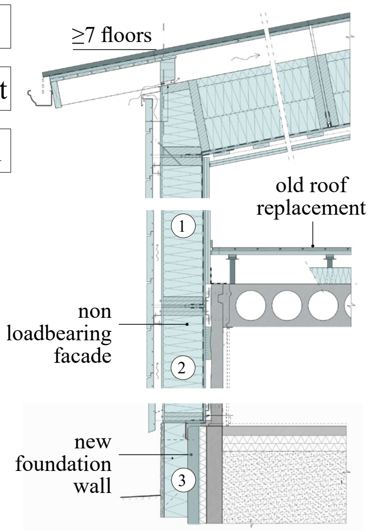
adapted 2009-2014

ADAPTATION METHODS

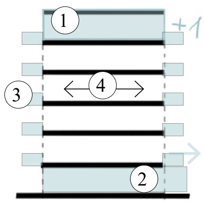
1 Floor addition
2 Cladding replacement
3 New foundation wall

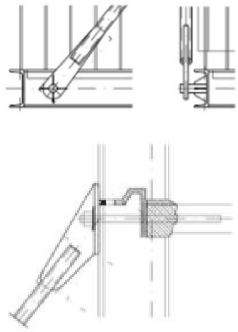


new facade / roof elements
existing concrete structure



1 Floor addition
2 Plinth activation
3 Balconies addition
4 Apartments alteration



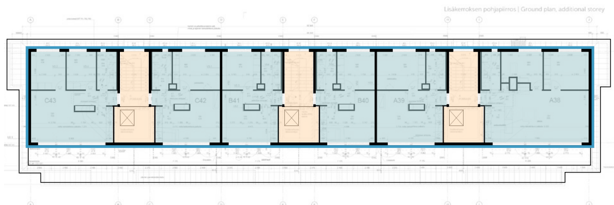


3 balcony joint detail

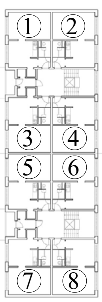
FLOORPLAN

residential circulation
storage renovated
replaced added

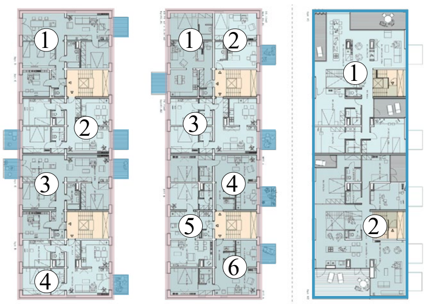
added new top floor



before adaptation



after adaptation



1 number of apartments

typical floorplan

roof

SOURCES

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Appendix 3

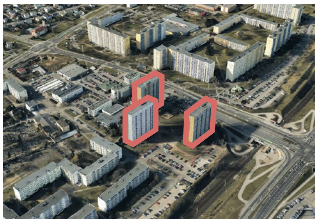
DATA

Sequence number	B5
Location	B. Chrobrego, Poland
Net floor building area	10100 m2 (x3)
Original number of apartments	160 (x3)
Apartments after renovation	-
Developer	Public

Sequence number	B6
Location	Gartenstadt Süd, Germany
Building area	784 m2 (x3)
Original number of apartments	-
Apartments after renovation	4-11
Developer	Social housing (GEWOBA)

CONTEXT

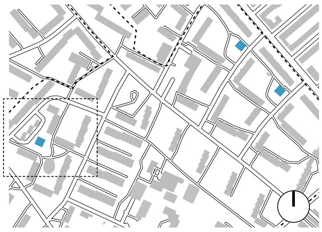
top view



site plan

renovated buildings
estate area

masterplan

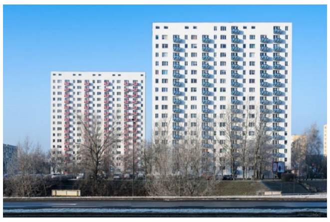


site plan

new buildings
estate area

IMAGE

estate, 1970s



adapted 2012

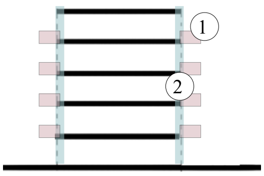
Hinrich Fehrs street,
built 1960s

adapted 2017

ADAPTATION METHODS

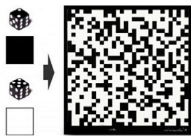
1 Balconies renovation

2 New facade

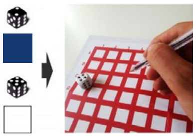


new facade with insulation
renovated balconies

art inspiration



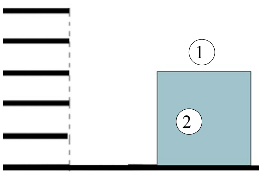
residents participation



unique balcony pattern

1 Densification in between

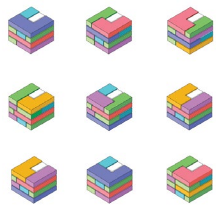
2 Apartments alteration



new residential building

prefabricated system

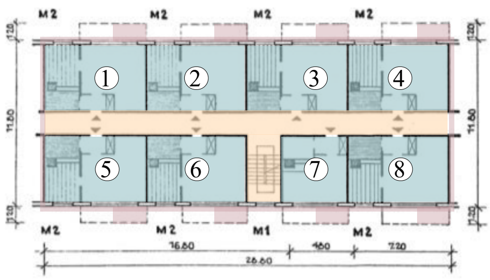
serial diversification



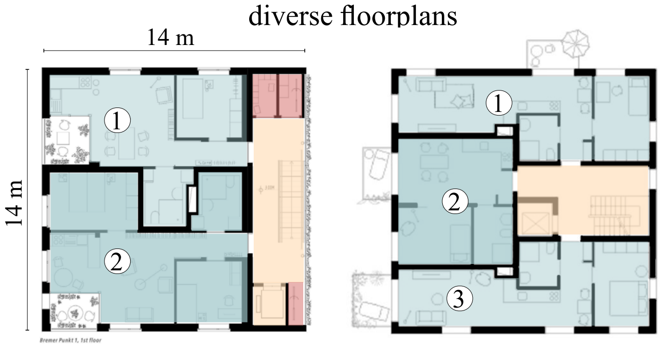
FLOORPLAN

replaced
added
storage
renovated
residential
circulation

"Szczeciński" system typical floorplan



diverse floorplans



SOURCES

„Miastoprojekt-Szczecin" (1971) *Budownictwo mieszkaniowe z elementów wielkowymiarowych*: 9. Szczecin.
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https://www.lin-a.com/gallery/bremen-competition-lin-project-housing/bremer-punkt

Appendix 4

DATA

Sequence number	B7	Sequence number	B8
Location	Forsythienstraße 3-13, Germany	Location	Wilhelmsruher Damm, Germany
Net floor building area	-	Building area	68.307 m2
Original number of apartments	252	Original number of apartments	977
Apartments after renovation	86	Apartments after renovation	977
Developer	Social housing (EWG)	Developer	Social housing (GESOBAU)

CONTEXT

top view

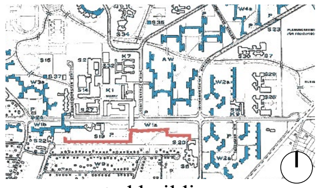
1 renovation phase
case study area: 2nd phase

site plan

new buildings
renovated buildings

top view

site plan



renovated buildings
Langer Jammer

IMAGE

estate, 1970s

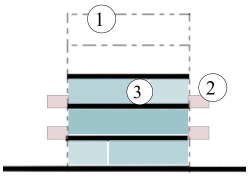
adapted 2012

built 1965-68

adapted 2015

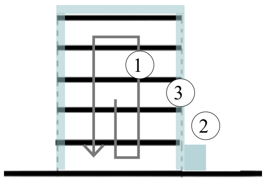
ADAPTATION METHODS

1 Selective demolition
2 Balconies renovation
3 Layouts alteration



disassembly process of WBS-70 large concrete panels

1 Services improvement
2 Groundfloor extension
3 Envelope energy retrofit



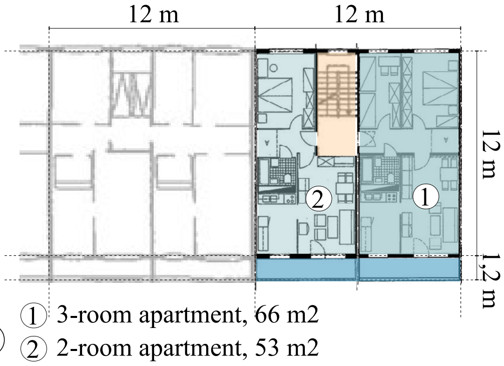
2 renovation of entrance pavilions

3 EIFS facade system

FLOORPLAN

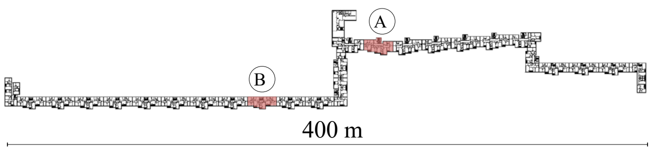
replaced
added
storage
renovated
residential
circulation

typical WBS-70 floorplan (2-5 floor)

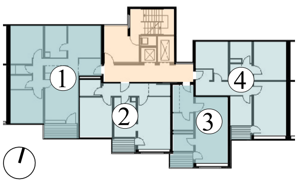


1 3-room apartment, 66 m2
2 2-room apartment, 53 m2

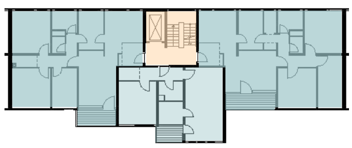
1st floor



module A



module B



SOURCES

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https://www.db-bauzeitung.de/architektur/wohnungsbau/grossmasss-taebliche-wohnwertsteigerung/
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