STRUCTURAL XPLORATION LAB

Zürich – Stadtspital Triemli Personalhäuser

Resource assessment of structural elements

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Disclaimer: This report is a preliminary resource assessment and should be used as such. The results presented are based on visual inspections and on limited material testing. Material properties and detailed condition of each elements should be further assessed prior to any reuse of the elements described herein. The authors deny all liabilities with respect to the use of the information given in this report.

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Summary

The Triemli Personalhäuser are three equal 15-story buildings located on the Zürich Triemli Stadtspital campus and erected between 1964 and 1969. Cast-in-place reinforced concrete (RC) slabs and walls form the building cores and their surrounding corridors. The rooms are arranged around these cores. The load-bearing intermediate walls, made of prefabricated masonry, support thin precast slabs used as permanent forms. A RC layer is cast over these precast slabs and connects the room slabs with the cast-in-place slabs of the corridors and cores. The self-supporting facade consists of precast RC panels. The City of Zürich plans the deconstruction of these three buildings, thus making available a large amount of RC elements composing the structure and the facades of these buildings.

Little-known and rarely implemented, the reuse of concrete elements from obsolete buildings in new projects is a sustainable approach that promotes a circular economy. When reusing, the components of obsolete buildings are carefully dismantled without being crushed. They are then cleaned, possibly repaired or trimmed, and reused without many transformations in a new project, maintaining their shapes, technologies, and mechanical properties. In addition to maintaining the embodied energy and history of the reused components, reuse allows the construction industry to reduce demolition waste, greenhouse gas emissions, and material consumption.

This report is a preliminary resource assessment and aims at inventorying and assessing all structural elements of the Triemli Personalhäuser, focusing on their potential value for reuse. Both precast and cast-in-place RC elements are included. They are part of the load-bearing structure or are self-supporting such as the precast facade elements. The proposed methodology allows identifying all properties needed to evaluate the potential for reuse of an element: geometry, material properties, current condition, aesthetics, accessibility, resistance, future durability and environmental impacts. After reviewing available reports and drawings on the buildings, on-site visits are carried out to complete the information and visually inspect the structural elements. During the inspection, the elements are assessed with regards to their suitability for reuse and their condition is classified into a five-grade scale. The investigations are completed with destructive and non-destructive testing of the material properties.

Together, Buildings A, B and C are made up of approximately 7 000 m3 of materials constituting their load-bearing system, with approximately 2 500 m3 of precast concrete, 3 400 m3 of cast-in-place concrete and 1 100 m3 of masonry. Of this total, approximately 4% of the volume is dropped from the analysis due to the bad condition of the elements, namely the balcony slabs, the roof slab, and the external stairs. The other elements are in a good or acceptable condition and ae inventoried and analysed in detail.

The inventoried elements are divided into 5 categories: (1) facade elements; (2) slab elements; (3) wall elements; (4) column elements; and (5) staircases. Each of these categories are subdivided into a certain number of element types for which a complete factsheet is prepared, including pictures, drawings and useful information on their condition. The volume and weight of each element types are given, as well as their share of the total material volume. The embodied global warming potential (in kgCO2eq) for fabrication and demolition of the elements is also calculated. The results of the investigation on material properties confirm sufficient compressive strength for all elements. The carbonation depths measured on the cores are lower than the cover thickness of the reinforcement. Thus, the concrete is not carbonated in the reinforcement areas and the risk of corrosion is kept low, insuring a good durability of the elements.

This document should serve as a base for designing and planning future reuse applications for the concrete elements extracted when deconstructing the Triemli Personalhäuser. The information presented here will help the planners to prioritize the reuse strategy on the elements in the best conditions, with the largest volume share and thus with the largest embodied global warming potential.

Zusammenfassung

Bei den Triemli Personalhäusern handelt es sich um drei gleiche 15-geschossige Gebäude auf dem Gelände des Triemli Stadtspitals Zürich, die zwischen 1964 und 1969 errichtet wurden. Stahlbetondecken und -wände in Ortbetonbauweise bilden die Gebäudekerne inklusive umlaufender Korridore. Um die Kerne herum sind die Zimmer angeordnet. Die tragenden Zwischenwände aus vorgefertigtem Mauerwerk stützen die als verlorene Schalung verwendeten vorgespannten Halb-Fertigteildecken. Der Überbeton verbindet die Halbfertigteildecken der Zimmer mit den Ortbetondecken in Korridor und Kern. Die selbsttragende Fassade besteht aus Betonfertigteilen. Die Stadt Zürich plant den Rückbau dieser drei Gebäude, womit große Mengen an Stahlbetonelementen aus deren Tragwerk und Fassade verfügbar werden.

Die Wiederverwendung von Betonelementen aus dem Rückbau von Gebäuden in neuen Projekten ist ein nachhaltiger Weg zur Förderung der Kreislaufwirtschaft, der bisher wenig bekannt und auch nur selten umgesetzt wurde. Bei der Wiederverwendung werden die Bauteile ausgedienter Gebäude sorgfältig demontiert, ohne sie zu zerstören. Anschließend werden sie gereinigt, gegebenenfalls repariert oder zurechtgeschnitten und ohne große Veränderungen in einem neuen Projekt wiederverwendet, wobei ihre Form sowie ihre technischen und mechanischen Eigenschaften erhalten bleiben. Durch die Wiederverwendung bleiben nicht nur die graue Energie und die Geschichte der wiederverwendeten Bauteile erhalten, sondern sie ermöglicht es der Bauindustrie auch, Abbruchabfälle, Treibhausgasemissionen und den Materialverbrauch zu reduzieren.

Dieser Bericht ist eine vorläufige Ressourcenanalyse mit dem Ziel, alle strukturellen Elemente der Triemli Personalhäuser zu inventarisieren und zu bewerten, wobei der Schwerpunkt auf ihrem potenziellen Wert für die Wiederverwendung liegt. Es werden sowohl vorgefertigte als auch in Ortbeton erstellte Stahlbetonbauteile berücksichtigt. Es handelt sich dabei um Teile der Tragkonstruktion oder um selbsttragende Elemente wie die vorgefertigten Fassadenelemente. Die vorgeschlagene Methode ermöglicht die Erfassung aller Eigenschaften, die für die Bewertung des Wiederverwendungspotenzials eines Elements erforderlich sind: Geometrie, Materialeigenschaften, aktueller Zustand, Ästhetik, Zugänglichkeit, Tragfähigkeit, künftige Dauerhaftigkeit und Umweltauswirkungen. Nach Durchsicht der verfügbaren Unterlagen und Zeichnungen zu den Gebäuden dienen Besuche vor Ort der Vervollständigung der Informationen und der visuellen Inspektion der Tragwerkselemente. Ergänzt werden die Untersuchungen durch zerstörende und zerstörungsfreie Prüfungen zur Ermittlung der Materialeigenschaften.

Die Tragsysteme der Gebäude A, B und C bestehen zusammengenommen aus ca. 7 000 m3 Baumaterial, wovon ca. 2 500 m3 auf Betonfertigteile, 3 400 m3 auf Ortbeton und 1 100 m3 auf Mauerwerk entfallen. Ungefähr 4 % des Volumens fallen aufgrund des schlechten Zustands der Elemente aus der Analyse heraus, namentlich die Balkonplatten, die Dachplatte und die Außentreppe. Die übrigen Elemente befinden sich in einem guten oder akzeptablen Zustand und wurden inventarisiert und im Detail analysiert.

Die inventarisierten Elemente sind in 5 Kategorien unterteilt: (1) Fassadenelemente; (2) Deckenelemente; (3) Wände; (4) Stützen und (5) Treppenhäuser. Jede dieser Kategorien ist in die entsprechende Anzahl von Elementtypen unterteilt, zu denen jeweils ein vollständiges Datenblatt mit Bildern, Zeichnungen und wichtigen Informationen über ihren Zustand erarbeitet wurde. Für jeden Elementtyp werden Volumen und Gewicht sowie der Anteil am Gesamtmaterialvolumen angegeben. Außerdem wurden die Treibhausgasemissionen (in kgCO2eq) für die Herstellung und den Abriss der Elemente berechnet. Die Ergebnisse der Untersuchung der Materialeigenschaften bestätigen eine ausreichende Druckfestigkeit für alle Elemente. Die an den entnommenen Bohrkernen gemessenen Karbonatisierungstiefen sind geringer als die Überdeckungsdicke der Bewehrung. Das bedeutet, dass der Beton in den Bewehrungsbereichen nicht karbonisiert ist und das Korrosionsrisiko gering ist, wodurch eine gute Haltbarkeit der Elemente gewährleistet ist.

Dieses Dokument soll als Grundlage für die Gestaltung und Planung zukünftiger Einsatzmöglichkeiten, für die beim Rückbau der Triemli Personalhäuser gewonnenen Betonelemente dienen. Die hier präsentierten Informationen werden den Planenden helfen, eine Wiederverwendungsstrategie basierend auf den Bauteilen zu erarbeiten, die sich in einem optimalen Zustand befinden, den grössten Volumenanteil aufweisen und somit die grösste Einsparung an Treibhausgasemissionen ermöglichen.

1 Introduction

1.1 Triemli Personalhäuser

The Personalhäuser are three buildings (A, B and C) located on the Zürich Triemli Stadtspital campus (Figure 1), erected between 1964 and 1969. They were planned by an architects group (E. Schundler, R. Hässig, E. Müller, R-. Joss, R Hauber and Dr. Rohn) and structural engineer E. Schubiger.

Each building has 15 floors and an attic for a total height of 43 meters and occupies a surface area of 30.1 by 16.7 meters. They have a common basement which serves as the heating and power plant for the hospital. Cast-in-place reinforced concrete (RC) slabs and walls form the building cores and their surrounding corridors. The rooms are arranged around these cores. The load-bearing intermediate walls, made of prefabricated masonry, support thin precast slabs used as permanent forms. A RC layer is cast over these precast slabs and connects the room slabs with the cast-in-place slabs of the corridors and cores. The self-supporting facade consists of precast RC panels (Figure 1).

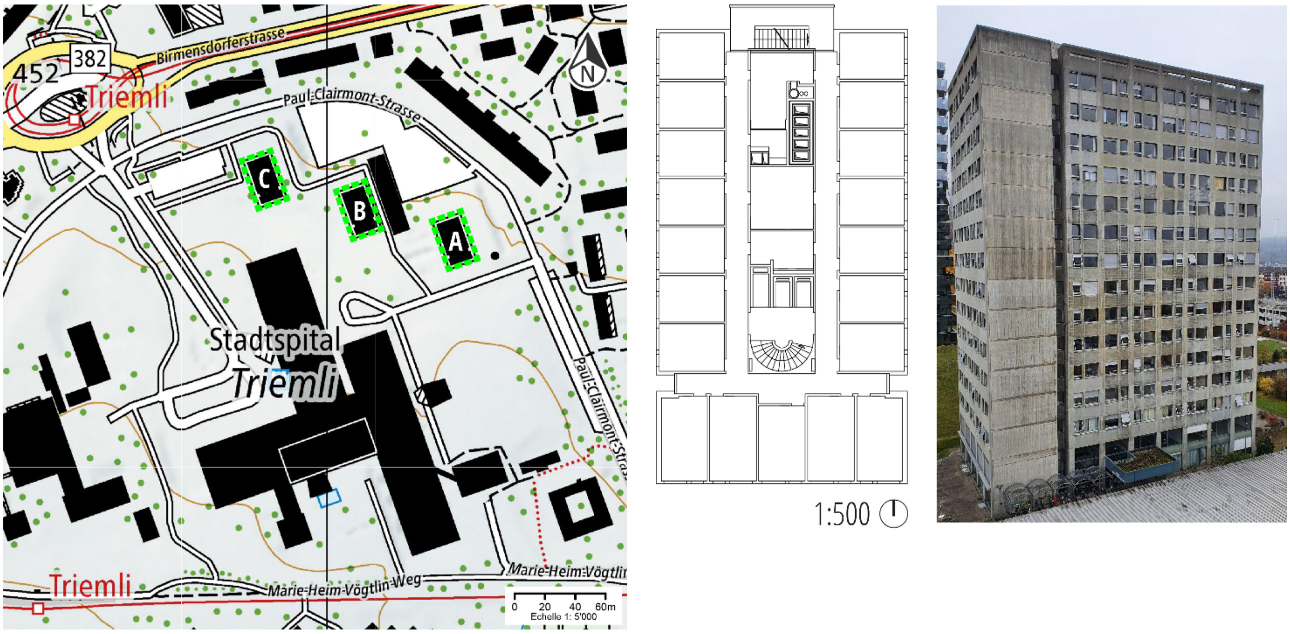


Figure 1. Triemli Personalhäuser - Localization plan, typical floor plan and facade of building B

These three buildings are representative of constructions methods widely developed after WWII. At the time, construction is rationalized, and prefabrication is industrialized [1,2]. High-rise dwelling buildings are particularly suitable for these methods with their repetitive floor plans.

The City of Zürich plans the deconstruction of these three buildings, thus making available a large amount of RC elements composing the structure and the facades of these buildings. This document inventories and assess these elements with regards to their potential reuse in a new structure.

1.2 Concrete Reuse

1.2.1 Definition and motivation

The construction industry is responsible for a significant portion of the detrimental effects caused by humans on the environment. The industry of concrete, the most ubiquitous construction material, is particularly harmful to the climate and biodiversity. For example, the production of cement, a key component of concrete, is accountable for 9 % of all process-related CO2 emissions [3]. Concrete is the most used material globally and the largest source of construction waste in Europe [4]. Concrete waste is often generated during demolitions caused by socio-economic reasons, although elements of demolished buildings are often in good conditions and could be used longer. While the industry today favors energy-intensive recycling of concrete waste, an environmentally more efficient strategy is the direct reuse of concrete elements.

Little-known and rarely implemented, the reuse of concrete elements from obsolete buildings in new projects is a sustainable approach that promotes a circular economy. When reusing, the components of obsolete buildings are carefully dismantled without being crushed, using for example a diamond saw to separate them. Once salvaged, components are cleaned, possibly repaired or trimmed, and reused without many transformations in a new project, maintaining their shapes, technologies, and mechanical properties. In addition to maintaining the embodied energy and history of the reused components, reuse allows the construction industry to reduce demolition waste, greenhouse gas emissions, and material consumption. On the other hand, reuse requires detailed a diagnosis of components at an early stage, a careful selective deconstruction process, and finally synchronization with a project that will reuse the components and whose design process is tailored to the specificities of reuse.

From an ecological perspective, the most efficient approach to reuse is to avoid underutilizing or downgrading a reusable component. Instead, the new project should fully take advantage of the component remaining capacities. For example, if a component was originally built to support structural loads, the new project should ideally reuse the component for a similarly demanding load-bearing function.

Concrete reuse is environmentally preferable to concrete recycling. Indeed, even though recycled concrete limits landfilling, it requires an energy-intensive manufacturing process and as much new cement as new concrete, if not more. However, it is essential to note that maintenance and in-situ renovation of buildings and concrete structures should always be preferred to reuse every time building removal can be avoided.

1.2.2 State-of-practice

Although the reuse of concrete is a little implemented practice, several projects reusing precast or cast-in-place concrete in Europe have been identified and documented. Those pioneer projects demonstrate the technical feasibility of the approach and its potential towards a more sustainable construction sector.

While the structure of the Triemli-Hosptial staff-housing buildings mixes precast and cast-in-place concrete, a clear difference is identified in the state of the practice and knowledge between the reuse of precast and cast-in-place concrete. Regarding the reuse of precast components, completed projects in Europe have reused structural components of several precast systems for structural purposes, mainly in housing projects. Compared to cast-in-place concrete, the reuse of precast concrete is eased by the intrinsic qualities of such a construction method, namely, among others, the use of defined components, the repetitiveness of the system, the expected homogeneity of the quality of the concrete cast in the factory. In addition, the repeated experiences on similar systems allow building on past experiences.

Examples of buildings reusing **precast concrete components** in Germany, Sweden, the Netherlands, and Finland have been documented. The following presents a selection of built examples reusing precast concrete components for structural purposes.

> In 2001, what is described as the first pilot project of Germany was built [5]. The prototype is a two-story pavilion built with precast components of the German system WBS70 at TU Berlin (Figure 2).

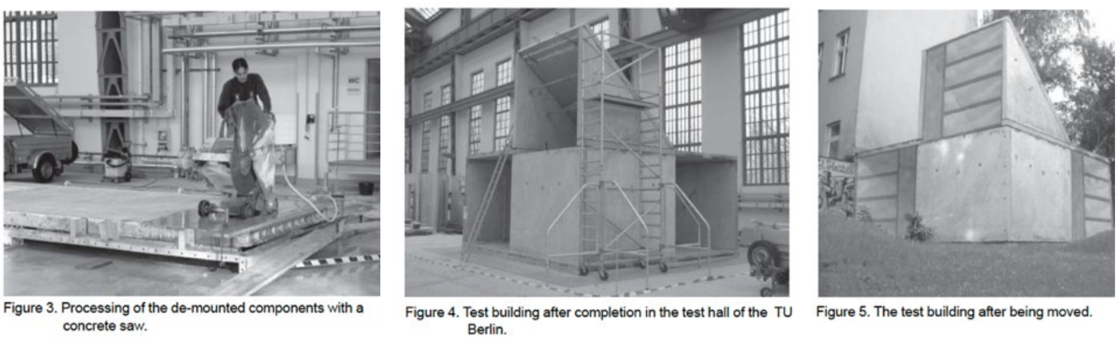


Figure 2. Prototype building built with precast concrete components. [5]

> In 2008, under the direction of Prof. A. Mettke, Heyn et al. collected in a report a large selection of projects in Germany that reuse precast components of which residential and facility buildings [5]. Most examples reuse components of the mass-produced DDR

WBS70 precast system and do not exceed two stories. For most projects, economic benefits are quantified. Built examples include the first pilot house in Mehrow and the second one in Schildow (Figure 3).

Figure 3. First pilot house reusing WBS70 concrete panels. [5]

> In 2019, Huuhka et al. [6] investigated, among others, two older pioneer projects built reusing precast concrete elements for structural purposes in multi-story residential buildings. The case studies are located in Gothenburg (Sweden), and Middelburg (The Netherlands). The projects reuse elements from multi-story residential buildings deconstructed in 1984 and 1986, respectively (Figure 4).

Figure 4. Housing buildings built using reused precast panels: the Gothenburg (left) and the Middelburg (right) [6]

Conversely, the reuse of **cast-in-place concrete elements** for structural purposes is more limited. Projects reusing cast-in-place concrete for non-structural mostly downcycle the structural concrete and use it for non-structural functions such as exterior landscaping or visual partitions. The following presents a selection of examples reusing cast-in-place concrete:

> Since 2017, the French team Bellastock has explored the potential of reusing concrete [7]. Today, most applications downcycle concrete in pavment, outdoor equipment, and visual partitioning (Figure 5).

Figure 5. Reuse of concrete in La Fabrique du Clos by Bellastock [7]

> In 2021, the Swiss architects reused cast-in-place concrete from several demolitions sites to pave the ground floor of two buildings in Geneva (Figure 6).

Figure 6. Concrete sourcing and reuse for the pavement of the ground floor of a building in Geneva (Ingeni SA, C. Küpfer)

> In 2021, the EPFL Structural Xploration Lab designed and built of prestressed footbridge that reuses 25 cast-in-place-concrete blocks from a building undergoing renovation in the region (Figure 7). Constructed without pouring new concrete, the reused-concrete footbridge is 70 % more environmentally efficient than a similar design build with new or recycled concrete and rivals a timber footbridge.

Figure 7. Footbridge built from reused concrete blocks by the Structural Xploration Lab (EPFL)

1.2.3 Techniques

To promote the reuse of construction wastes, deconstruction is caried out in a selective way. This procedure consists in separating and dismantling the components of a building while minimizing waste production [8]. The intrinsic properties of the building component, evaluated through an evaluation protocol, are therefore recovered, making it available for reuse. Various techniques are readily available to ensure a proper deconstruction, storage and rehabilitation of RC components, whether they were precast or cast-in-place.

Precast concrete elements can be removed once their connections are undone, if they are accessible. The deconstruction of cast-in-place RC elements, such as slabs or walls, is less straightforward. These structural elements have no clearly identified connections and the deconstruction pattern must be defined according to lifting (see left picture in Figure 6), transportation and storage limitations.

Various techniques exist to remove or demolish hardened concrete [9,10]. Some of these methods can be applied to undo connexions filled with mortar or concrete or to extract cast-in place RC panels:

> Impact demolition, using hydraulic or pneumatic hammers (such as a jackhammer): Concrete is locally chipped away by the hammer, leaving a rough surface and deformed rebars. This method induces vibration and thus microcracking in the remaining concrete.

> Sawing the concrete using diamond blades or wires (see left picture in Figure 7): Concrete as well as the rebars present in it are sawn to create a neat surface.

> Hydrodemolition (or high-pressure water-jets): Concrete is locally removed while preserving the existing rebars. The concrete surface is left rough. This technique requires large amounts of water that then need to be treated.

In all cases, dismantling should always be done with great care, to limit the damage on the extracted elements. If necessary, they can then be stored until their reuse, in a way that will preserve their quality. The recommendations listed below should be followed:

> Edges are protected when the elements are lifted or transported to prevent any chipping.

> Elements previously used in a vertical position, such as walls or facade elements, can be stored horizontally provided they have sufficient reinforcement to prevent any cracking under self-weight.
> Horizontally stored elements are simply supported on two points (or more if required by the reinforcement rate) using dunnage wood pieces (or support spacers), thus allowing humidity to evacuate. RC panels should never be stacked without spacers, directly on top of each other.
> The number of elements stacked on top of each other depends on the lifting capacity on site. However, support spacers are aligned between the different levels (see central picture in Figure 7).
> Anchor points remain accessible.
> The storage area should be covered, or the RC elements should be protected with plastic sheets to prevent exposure to direct rain.

Prior to reuse, the reclaimed elements can be rehabilitated or, if necessary, strengthened. Various techniques are described in the European standards EN 1504 [11] for existing RC structures and can be extended to the case of reuse:

> Concrete repair: Once the locally damaged concrete is repaired, the element is repaired using appropriate mortars.
> Concrete protection: If the reclaimed concrete element is reused in an outdoor environment, its surface should be protected from any ingress, and especially from water and humidity. This can be done with hydrophobic impregnations or coatings.
> Structural strengthening: If needed for the future reuse application, the RC elements can be strengthened with externally bonded reinforcement, such as Fiber Reinforced Polymer (FRP) lamellas or a layer of Ultra-High Performance Fiber Reinforced cement-based Composite (UHPFRC).

1.3 Scope and objectives

This report aims at inventorying and assessing all structural elements of the Triemli Personalhäuser, focusing on their potential value for reuse. The methodology, detailed in chapter 2, aims at identifying all properties needed to evaluate the potential for reuse of an element: material properties, actual condition, aesthetics, accessibility, resistance, future durability and environmental impacts. Deconstruction, storage and rehabilitation methods are out-of-scope of this report and were briefly reported in section 1.2.3.

The complete resource assessment of the buildings structural elements is then presented in chapter 3. The elements are divided into 5 categories: (1) facade elements; (2) slab elements; (3) wall elements; (4) column elements; and (5) staircases. Each of these categories are subdivided into a certain number of element types for which a complete factsheet is prepared, including pictures, drawings and useful information on their condition. Both precast and cast-in-place RC elements are included in the inventory and assessment. These elements are part of the load-bearing structure or are self-supporting such as the precast facade elements. The following building components are considered as out-of-scope for this report:

> Non-bearing partitions, doors and windows;
> HVACS technical equipment;
> Any electrical equipment;
> All finishing layers;
> Furniture.

Buildings A, B, and C are remarkably similar in terms of construction plans and period and have been exposed to the weather and used in nearly the same manner. Therefore, a main assumption of the report is that the three buildings have similar components and damage. The investigations focused on building A as a preliminary study, and should be valid for buildings B and C. The numbers presented in the tables and factsheets include all three buildings by interpolation of the observations made on building A. However, the results presented in this report are based on visual inspections and on limited material testing. Material properties and detailed condition of each elements should be further assessed prior to any reuse of the elements described herein.

2 Methodology

2.1 Preamble

This methodology describes the steps taken to assess the different structural elements of the Triemli Personalhäuser. It is based on the report "*Reuse of precast concrete, reinforced and prestressed concrete elements*" produced LBV-Landesmt für Bauen und Verkehr des Landes Brandenburg [12] as well as swiss standards for existing structures [13] and personal experience.

The protocol is divided into several steps:

> Review of existing data;
> On-site inspection to support theorical information collected in existing data and inspect the structural elements;
> Characterization of building materials through investigation;
> Identification and assessment of elements suitable for reuse.;
> Preparation of factsheets for each element type.

Each of these steps is further described below while all assessment results are given in chapter 3 with the element factsheets.

2.2 Review of existing data

All existing data such as construction plans, drawings and reports are reviewed and the relevant information is summarized and included in the element factsheets, described in chapter 2.6.

2.3 On-site visits

The site visits have various goal listed below:

> Verify the consistency between the information collected from the existing data and what is built;
> Define the location of the destructive investigations (see paragraph 2.4.1);
> Carry out the non-destructive investigations (see paragraph 2.4.2);
> Conduct a visual inspection of the building and its structural elements [12] to identify damages and asses the element condition, aesthetics and accessibility (see chapter 2.5);
> Discard any element unsuitable for reuse because of bad or failure condition (see paragraph 2.5.1).

2.4 Investigations on material properties

2.4.1 Destructive investigations

The destructive investigations consist of boring through the elements to extract cores on which rebar concrete covering and different overlay thicknesses are measured. A minimum of three cores are extracted in each of the main element categories (precast facade elements, cast-in-place walls and slabs) In some cases, boring is also done to help understanding the connection method between precast elements.

The extracted concrete cores are tested to obtain the compressive strength of concrete, as described in the EN 12504-1 standard [14]. For each series of three cores, the mean value of compressive strength and the standard deviation is obtained. Then, the actualized characteristic value for the compressive strength of this element category can be calculated with equation 1, according to the SIA 269/2 standard for existing concrete structures [13].

$$f_{ck,act} = f_{cm} - k(N) \cdot s \qquad (1)$$

The carbonation depth is measured on the split surface of the cores, using phenolphthalein, in accordance to the EN 14630 standard [15]. Carbonatation is the chemical reaction between the carbon dioxide (CO_2) contained in the air and the calcium hydroxide ($Ca(OH)_2$) dissolved in the pore solutions of concrete. It produces solid calcium carbonate ($CaCO_3$) which tends to harden the affected concrete, while reducing the pH of the pore solutions. If the carbonatation depth is higher than the concrete cover thickness, the lower pH solution increases the risks of rebar corrosion in the presence of water.

2.4.2 Non-destructive investigations

Non-destructive investigations are also conducted. The compressive strength of concrete is estimated using a Schmidt rebound hammer (Figure 8). With springs and a sliding mechanical mass, the rebound hammer measures the ratio between mass kinetic energies before and after impact which is then correlated to the compressive strength of the concrete element [16]. It is basically a surface hardness tester and the results are influenced by carbonatation [17]. For this reason, a first series of on-site rebound-hammer measurements are correlated with the results of the compressive tests on extracted cores. Once the correlation is established, the rebound hammer can be used at various location to confirm the concrete resistance.

Figure 8. Schmidt rebound hammer measurements.

Measurements are carried out on three different zones for each of the main element categories (precast facade elements, cast-in-place walls and slabs). The results of the measurements are analyzed as for the cores, using the mean and the standard deviation to obtain the characteristic value of the compressive strength (equation 1).

2.4.3 Other investigations

The yield strength of the steel rebars is estimated based on the construction year of the building, information found on construction drawings and the steeldata.ch database [18]. This database by EMPA provides material characteristics for steel rebars by year of production and supplier. In later stages of the project, the yield strength of the rebars should be verified by taking bar samples and testing them. The results could then be analyzed as for the concrete cores to obtain the actualized characteristics value of the yield strength, using again equation 1.

2.5 Assessment of elements

2.5.1 Condition

One of the most complex tasks of the resource assessment of structural elements is to assess the elements condition. The visual inspection revealed damage to the building elements that must be properly interpreted and understood. A five-grade classification of the element conditions is proposed in Table 1. The grades are based on the scale (small to large), the extent (localized to extended) and the degree (light to heavy) of damage and on the impact that it may have on the structural behavior of the element. These grades define whether the element is suitable for reuse as a load-bearing and/or non-load-bearing element, with or without rehabilitation process.

This report asses each element types as a group. As some elements of the group may have defects while others do not, the results are given in proportion of the observations made. To do this, the condition of each elements is graded by visual inspection and then the proportions are then obtained for the group. For example, for the precast facade elements, the results may be as follows: 30 % of the elements are in a good condition, 55 % of the elements are in an acceptable condition, 10 % of the elements are in a deviant condition and 5 % of the elements are in a bad condition. For cast-in-place elements the methodology is the same, but it applies to the surface area of the elements rather than the number of elements.

Grade	Condition assessment	Damage level	Examples of observed damages	Reusability assessment
1	Good condition	None	None	> Suitable for reuse as a load-bearing element > Suitable for reuse as a non-load bearing element
2	Acceptable condition	Small and localized zones of light damage on exposed surfaces → Affects the durability	Small, local and light: water stains, chipped concrete, corrosion spots, …	> Suitable for reuse as a load-bearing element after basic rehabilitation > Suitable for reuse as a non-load bearing element
3	Deviant condition	Localized zones of light damage on exposed surfaces → Affects the serviceability	Local and light: localized cracking, chipped concrete, locally exposed corroded rebars, …	> Complete rehabilitation needed to be reused as a load-bearing element > Suitable for reuse as a non-load bearing element
4	Bad condition	Localized zones of damage on exposed and vulnerable surfaces → Affects the security	Local but noticeable: water infiltration, cracking, spalling concrete, exposed corroded rebars, …	> May be reused as non-load-bearing element if appropriate durability conditions are met.
5	Failure condition	Large and extended zones of heavy damage on all surfaces → Inadequate security	Large and heavy: water infiltration and efflorescence, heavy cracking, large zones of spalling concrete, exposed corroded rebars, …	> Not suitable for reuse

Table 1. Grades for condition assessment of elements

2.5.2 Aesthetics

The aesthetics of the elements is mainly defined by the color and the finishing of the concrete surface, first evaluated by visual inspection. The color of the elements is then matched to a RAL color chart number. As the color is not necessarily uniform over the entire surface the closest RAL correspondence is chosen and information about shades or tints (for example yellow or blue tint) is given in the factsheet. The finish of the concrete surface depends on the type of formwork used during construction which can leave some patterns or marks on the surface. This can be observed directly on the elements if their surface is visible.

2.5.3 Accessibility

The accessibility of the concrete element is ranked on four levels:

- Easy if no other elements should be dismantled before the concerned element.
- Moderate if one or two (small number) other elements should be dismantled beforehand to allow the disassembly of the concerned element.
- Difficult if three and more (medium to large number) elements should be dismantled beforehand to allow the disassembly of the concerned element.
- Very difficult if all the building should be dismantled beforehand. In other words, if it is the last element of the building that can be dismantled.

This characterizes the ease and speed with which the element can be made available after the deconstruction of the building has begun.

2.5.4 Cross-section resistance

The cross-section moment resistance of the element is estimated using equation 2, a simplified approach for concrete sections. The lever arm between internal forces is assumed to be equal to 0.9 times the static height of the concrete section. However, the static height is not always known precisely due to the lack of information on the concrete rebar cover, and it is estimated to be equal to 0.9 times the total height of the section. These approximations allow us to obtain a safe result for this phase of the project.

$$M_{Rd} = A_s \cdot f_{sd} \cdot z = A_s \cdot f_{sd} \cdot 0{,}9 \cdot d = A_s \cdot f_{sd} \cdot 0{,}81 \cdot h \qquad (2)$$

As shown in Figure 9, the cross-section moment resistance is computed for in the direction of the longest length of the element, as this is the direction that is likely to be load bearing for the new construction. For precast elements, the cross-section moment resistance is given for the whole width of the element whereas for cast-in-place elements, the cross-section moment resistance is given per linear meter.

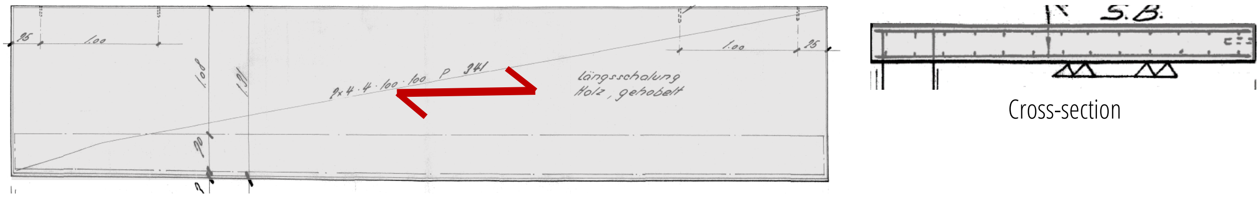


Figure 9. Cross-section resistance of concrete section

2.5.5 Durability

The durability of concrete elements can be heavily impacted by the corrosion of rebars which, as introduced in paragraph 2.4.1, has more risk of occurring if the cover concrete is carbonated. To evaluate the risks of corrosion, the measured carbonatation depth is compared to the concrete cover thickness measured on the same core.

2.5.6 Significance

The significance is the portion of the total concrete volume of the building that the considered type of element represents. This number shows the importance of an element and helps choosing which elements to maximize the volumes of material saved from landfill.

2.5.7 Environmental impacts

The embodied global warming potential (in kgCO_2eq) for fabrication and demolition of the elements is calculated using their weight and the equivalent factors available in the Life Cycle Assessment KBOB database [19]. The considered factors are the following: (1) Concrete for buildings (without reinforcement), KBOB ID-Number 01.002 and (2) "Brick", KBOB ID-Number 02.001. The weight of the RC elements is estimated based on the element volume and a RC density of 2'500 kg/m^3. The weight of the steel rebars is neglected, as this is compensated by considering a higher theoretical density for RC. However, the thickness of the screed placed over slabs is considered in the volume and the weight of the element. The result is approximate and does not include any work needed to extract and prepare the elements for a potential reuse. However, it gives an idea of which elements should be prioritized in the reuse strategy to reduce significantly carbon emissions.

2.6 Element factsheets

For each type of elements types, a detail factsheet collects all relevant information needed to plan its reuse. Their structure is as follows:

- Plans and photos location of the element type.
- Photos of the type.
- Detailed photos of the color and finishing of the type.
- Plans with the main dimensions of the most common sub-type, same for the cross-section.
- Description of the type with all information about the exposition, the initial function and location, the accessibility, the overlay, the connections, etc.
- Information on the condition and durability of the type as explained on chapter 2.5.
- Information on the mechanical characteristics of the type as explained on chapter 2.5.
- Inventory of the subtypes with their dimensions, cross-section resistance, quantity, significance, environmental impacts, etc.
- Additional information with attention point.

3 Resource assessment results

3.1 Preamble

The following presents the detailed resource assessment of the structural elements of the Triemli Personalhäuser. Results are presented following the methodological steps that are detailed in chapter 2.

The elements are separated into five categories:

> Facade element
> Slab element
> Wall element
> Column elements
> Staircase

Each of these categories is subdivided into a certain number of element types, illustrated in the figures of Annex 1 – Location of element types. These types are themselves subdivided into subtypes whit the same characteristics but slightly varying geometry. All relevant information from the assessment is summarized for each element type in the factsheets given in chapter 3.6.

3.2 Review of existing data

3.2.1 Document list

This report is based on the following documents describing the Triemli Personalhäuser. All other references are given in chapter 5.

Existing plans

A. Construction plans by architects group (*E. Schundler, R. Hässig, E. Müller, R-. Joss, R Hauber and Dr. Rohn*) and civil engineer (*E. Schubiger Dipl Bauing.*), 1964-1969
B. Plan views of the attic, *City of Zurich*,1987.
C. Renovation plans for buildings A, B and C, *Metron Architekturbüro AG* and *Baumann & Frey Architekten BSA SIA*, 2001.
D. Renovation plans for the temporary use of building C as a retirement home, *Aeschlimann Prêtre Hasler Architekten*, 2005-2016.

Existing reports

E. Report on soil conditions at the Triemli city Hospital, Dr. Hans Knecht, 1960.
F. Supplementary agreement on building use, Heyer Kaufmann Partner Bauingenieur AG, 2014
G. Building pollutants diagnosis (asbestos, PCB, PAH, etc.) – Personalhaus A, hpb consulting ag, version 2.0, 2021
H. Building pollutants diagnosis (asbestos, PCB, PAH, etc.) – Personalhaus B, hpb consulting ag, version 2.0, 2021
I. Building pollutants diagnosis (asbestos, PCB, PAH, etc.) – Personalhaus C, hpb consulting ag, version 2.0, 2021
J. Analysis of reuse of precast concrete element, Hemmi Fayet Architect AG, 2021
K. Management summary, Hemmi Fayet Architect AG, 2021
L. Deconstruction feasibility study, Eberhard Bau AG, 2021.

3.2.2 Summary of prior information

The following summarizes all prior and relevant information found in drawings and reports made available while preparing this report.

Existing plans

The construction drawings from 1964-1969 [A] include formwork and reinforcement plans for the various floors of the buildings. Thus, the dimensions of the precast and cast-in-place elements are available as well as the rebar layouts (diameter and spacing). Some connection details are also provided, which is useful to understand the construction system and therefore helps planning the deconstruction efficiently. To complete the information from the drawings, research in the archives of professional publications was carried out. Information could thus be found on the prefabricated Preton masonry walls in a 1966 publication [20] while images of the prefabricated pre-slabs, called PRELAM, was found in a 1973 add (Figure 10).

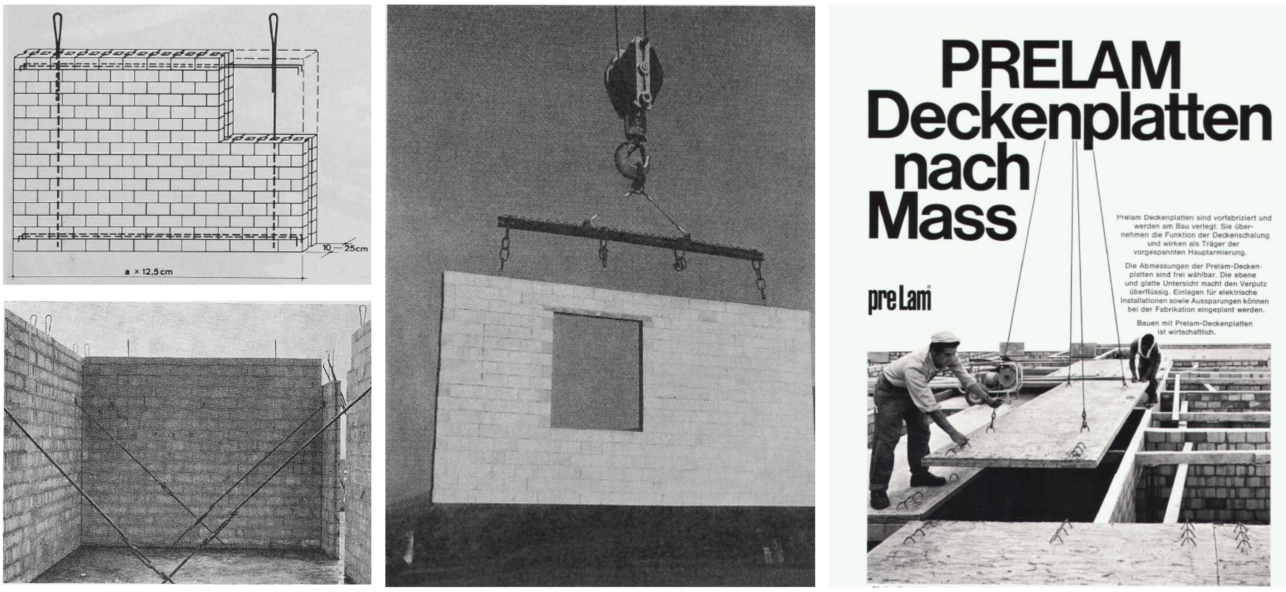


Figure 10. Prefabricated Preton walls (left and center) [20] and prefabricated Prelam slabs (right, from a 1973 add).

<u>Building pollutants diagnoses</u>

Toxicity reports [G,H,I] indicate the confirmed or suspected presence of asbestos in certain non-load-bearing elements (window joints, pipe covering, furniture etc.) as well as in some overlays of concrete elements (ceramic tiles and mortar). Regarding the plaster covering of walls, asbestos was detected in only two samples taken on the perimeter walls and not at all on the interior walls. The reports recommend that more sample are analyzed to confirm the suspicion of asbestos in the plaster covering of the perimeter walls. Finally, it is assumed that the PVC floorings are free of asbestos. The surfaces of the concrete load-bearing elements should be properly cleaned from any overlays or elements containing asbestos prior to any further dismantling for a possible reuse.

The cork insulation of the facade walls and the roof slab tested negative for polycyclic aromatic hydrocarbons (PAH) in all four-sampling location. The reports however recommend that all cork insulation be removed without breaking it, as a whole. This should be done prior to any dismantling for a possible future reuse.

Polychlorinated biphenyls (PCB) was detected in the waterproofing joint sealants between placed the precast RC facade elements, which is common for buildings built between 1955 and 1975 [21,22]. During deconstruction, the joint sealant should be completely removed by a specialized company. The removal can be done with a cutter, while avoiding heating the joints or producing dust. Contamination with PCBs of the concrete neighboring the joints should be checked by further sampling. Most probably, it will be necessary to remove 1cm of the edge that was in contact with the joint sealant.

Dismantling of all elements or overlays containing or with a suspicion of asbestos, PAH or PCB should be done by a specialized company. For any further information or action to be carried out in this regard, please refer to the relevant documents [G,H,I].

<u>Management summaries</u>

A report by Hemmi Fayet Architect AG [J] proposes a first inventory of the elements of the building facade. This information has been crossed with the data used in this report and is consistent.

Eberhard Bau AG [L] presented two alternative deconstruction methods of the buildings. The first one consists in crushing the concrete using a long-front demolition excavator. This solution is not compatible with the reuse of the structural elements. The second alternative proposes a deconstruction carried out from the top (roof) downwards (ground floor), floor by floor, using smaller machinery. Each building would than take a minimum of 11 months to deconstruct, and probably longer if a careful dismantling of the concrete elements is required.

3.3 On-site visits

A first visit took place on the 27th of October 2021. The following people were present:

> Charlotte Bofinger, civil engineer at Zirkular AG
> Maléna Bastien Masse, researcher and civil engineer at EPFL, Structural Xploration Lab
> Bruno Umbricht, Construction manager at Eberhard Bau AG
> Pascal Zimmermann, Head northwest of Eberhard Bau AG

During this visit, building A was visited and the facades of all three buildings were rapidly inspected. A first evaluation of the elements allowed a rough assessment of their condition and the discarding of elements in poor condition and not suitable for reuse. The location of the destructive investigations to be conducted (given in paragraph 3.4.1) was decided and discussed with the company Eberhard AG.

A second visit was made by the EPFL team, authors of this document, on the 23rd of November 2021. This visit, made after the destructive investigations, allowed to complete the information necessary for the elaboration of this document: pictures of building and elements; precise assessment of the condition of the facade elements; determination of the color and finishing of each element; taking notes on the destructive investigations carried out; visual inspection of interior elements; rebound hammer tests on typical elements (facade, slabs and walls).

3.4 Investigations on material properties

3.4.1 Destructive investigations

<u>Localization of the cores</u>

For the Triemli Personalhäuser, the following cores, localized on Figure 11, were done, all on level 9 of building A:

> 3 cores in the precast facade elements;
> 3 cores in the cast-in-place walls;
> 4 cores in the slabs;
> 1 core at the horizontal connection between precast facade elements;
> 1 diagonal core at the connection between the prefabricated masonry walls and the RC pre-slabs.

<u>Compressive test results</u>

The results of the compressive tests on the cores are given in Table 2. Test results for cores KB_DSO and KB_OI for walls were removed from the analysis because the values clearly stood out when compared to the other results, which suggests an error in the measurements. The detailed reports from the laboratory are given in Annex 3 – Compressive test results.

<u>Carbonatation and cover concrete thickness measurements</u>

The carbonatation depth measured on the different cores is compared to the cover concrete thickness in Table 3. The detailed reports from the laboratory are given in Annex 4 – Carbonatation and cover concrete thickness measurements.

The depths of carbonatation are always lower than the cover thickness of the reinforcement. Thus, the concrete is not carbonated in the reinforcement areas and the risk of corrosion is kept low.

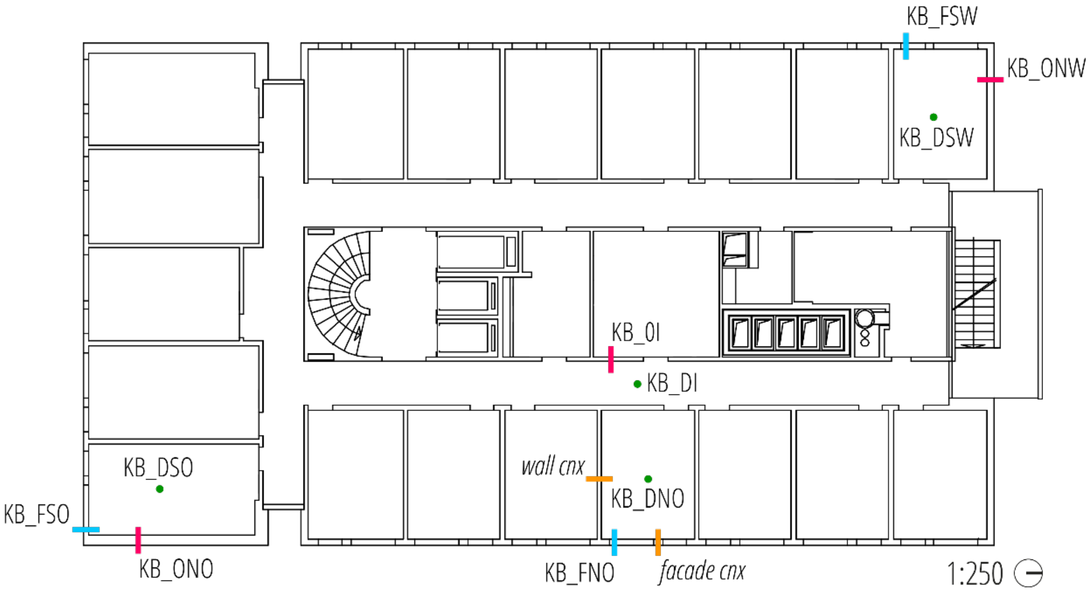


Figure 11. Localization of cores on floor plan

Results core testing			Characteristic values		
Facade elements					
KB_FNO	51,6	N/mm^2			
KB_FSO	58,6	N/mm^2			
KB_FSW	62,7	N/mm^2	s	5,61	N/mm^2
f_{cm}	**57,6**	**N/mm^2**	$f_{ck,act}$	41,2	N/mm^2
Slab elements					
KB_DNO	42,9	N/mm^2			
KB_DSW	40	N/mm^2			
KBL_DI	33,7	N/mm^2	s	1,67	N/mm^2
f_{cm}	**38,9**	**N/mm^2**	$f_{ck,act}$	25,1	N/mm^2
Cast-in-place wall and facade elements					
KB_ONO	72,1	N/mm^2			
KB_ONW	70,9	N/mm^2	s	0,85	N/mm^2
f_{cm}	**71,5**	**N/mm^2**	$f_{ck,act}$	69,0	N/mm^2

Table 2. Results of the compressive tests on cores

Cores	Average carbonation depth	Maximum carbonation depth	Cover thichkness of rebars	
Facade elements				
KB_FNO	16 mm	19 mm	45 mm	20 mm
KB_FSO	2 mm	6 mm	35 mm	16 mm
KB_FSW	10 mm	19 mm	28 mm	20 mm
Slab elements				
KB_DNO	< 1 mm	< 1 mm	-	25 mm
KB_DSW	< 1 mm	< 1 mm	-	20 mm
KB_DSO	< 1 mm	< 1 mm	-	25 mm
Cast-in-place wall and facade elements				
KB_DI	< 1 mm	< 1 mm	-	-
KB_DOI	12 mm	15 mm	-	-
KB_ONO	14 mm	16 mm	30 mm	40 mm
KB_ONW	8 mm	20 mm	28 mm	30 mm

Table 3. Carbonatation and cover concrete thickness measurements

3.4.2 Non-destructive investigations

<u>Localization of the test zones</u>

For the Triemli Personalhäuser, rebound-hammer measurements were made at the following location to establish a correlation with the tested cores:

- 3 zones on the balcony railing elements;
- 3 zones on the facade elements of ground floor;
- 3 zones at the soffit of cast-in-place slabs.

<u>Schmidt rebound hammer test results</u>

The concrete compressive strengths estimated using the Schmidt rebound hammer are given in Table 4. These results can now be correlated with the results of the compressive test. The correlation could then be used to interpret further measurements made with the Schmidt hammer on the structure.

It is not straight forward to establish this correlation and further measurements would be needed. As can be observed, the rebound hammer test results on carbonated surfaces did not always give a higher compressive strength values than the cores, as was expected. In the case of the cast-in place wall elements, the tested cores returned a higher compressive strength than the rebound hammer measurements.

Results Schmidt rebound hammer testing			Characteristic values		
Facade elements					
Zone 1	47,1	N/mm²			
Zone 2	45,1	N/mm²			
Zone 3	47,1	N/mm²	s	1,13	N/mm²
f_{cm}	**46,4**	**N/mm²**	$f_{ck,act}$	43,1	N/mm²
Slab elements					
Zone 1	39,2	N/mm²			
Zone 2	30,4	N/mm²			
Zone 3	33,4	N/mm²	s	4,50	N/mm²
f_{cm}	**34,3**	**N/mm²**	$f_{ck,act}$	21,2	N/mm²
Cast-in-place wall and facade elements					
Zone 1	52,0	N/mm²			
Zone 2	55,9	N/mm²			
Zone 3	52,0	N/mm²	s	2,27	N/mm²
f_{cm}	**53,3**	**N/mm²**	$f_{ck,act}$	46,7	N/mm²

Table 4 . Results of the tests with the Schmidt rebound hammer

3.4.3 Other investigations

The strength of the reinforcing steels was determined as mentioned in paragraph 2.4.3. The list of rebars available with the constrcution drawings showed that the steel was provided by Von Roll AG. For the years of construction from 1964 to 1969, the steeldata.ch database gives average steel strength of 550 N/mm². According to the SIA 269/2 standard for existing concrete structures [13], this corresponds to type IIIa or IIIb steels for the 1968 standards. A characteristic value for the steel yield strength of 450 N/mm² is thus estimated.

3.5 Assessment of elements

3.5.1 Discarded elements

Buildings A, B and C are made up of approximately 7 000 m³ of materials constituting their load-bearing system, with approximately 2 500 m3 of precast concrete, 3 400 m³ of cast-in-place concrete and 1 100 m³ of masonry. Of this total, approximately 4% of the volume had to be dropped from the analysis due to the bad condition of the elements. These are the balcony slabs (Figure 12), the roof slab (Figure 13) and the external stairs (Figure 14), listed in Table 5. The numbers (quantity, area and volume) are given as a total for all three buildings.

Discarded elements	Condition	Elements	Dimensions	Quantity	Area	Volume	Signifiance
Balcony slabs	Bad	-	6900 x 2930 x 200 mm	45 u	909.7 m²	182,0 m³	2,6%
Roof slabs	Bad	-	25840 x 7350 x 160 mm	569,8 m²	-	91,2 m³	1,3%
Outdoor stairs	Bad	n°19	2780 x 1350 x 2730 mm	42 u	157.6 m²	3,7 m³	0,1%

Table 5. Discarded elements

Figure 12. Balcony slabs

Figure 13. Roof slabs

Figure 14. Outdoor stairs

3.5.2 Selected elements

The elements with the best reuse potential are listed in the following tables and the detailed condition assessment of the facades is given in the figures of Annex 2 – Facade condition assessment results. The numbers (quantity, area and volume) given in the tables are a total for all three buildings. Any openings for pipes in the elements were ignored at this stage and only the perimeter dimensions are given.

Category	Material	Type N°	Element type	Condition	Element subtype	Element dimensions	Quantity	Area	Volume	Signifiance
Facade elements	Precast RC	01	Balcony railings	7% / 86% / 7%	n°19	6850 x 1310 x 120 mm	45 u	403,8 m^2	48,5 m^3	0,7%
		02	Ground- and 1st-floor column coverings	45% / 45% / 10%	n°1 to 8	4830 x 550 x 160 mm	66 u	175,3 m^2	28,1 m^3	0,4%
		03	Window apron walls	43% / 54% / 3%	n°39	1380 x 1280 x 160 mm	84 u	127,2 m^2	23,7 m^3	0,3%
					n° 14, 34, 35 and 96	3195 x 1280 x 160 mm	420 u	1717,6 m^2	274,8 m^3	4,0%
					n° 11, 30 and 31	3235 x 1280 x 160 mm	117 u	484,5 m^2	77,5 m^3	1,1%
					n° 95	3250 x 1280 x 160 mm	9 u	37,4 m^2	6,0 m^3	0,1%
					n° 15, 17, 36 and 38	3415 x 1280 x 160 mm	78 u	341,0 m^2	54,6 m^3	0,8%
					n° 91, 92, 93 and 94	3420 x 1280 x 160 mm	18 u	78,8 m^2	12,6 m^3	0,2%
					n° 13,16,33 and 37	3425 x 1280 x 160 mm	78 u	342,0 m^2	54,9 m^3	0,8%
					n° 10, 12, 29 and 32	3440 x 1280 x 160 mm	78 u	343,4 m^2	55,0 m^3	0,8%
		04	Walls between windows	79% / 20% / 1%	n° 26	280 x 1315 x 160 mm	741 u	272,8 m^2	43,7 m^3	0,6%
					n° 21 to 24	550 x 1315 x 160 mm	234 u	169,2 m^2	27,1 m^3	0,4%
					n° 27	650 x 1315 x 160 mm	468 u	400,0 m^2	64,0 m^3	0,9%
					n° 25	690 x 1315 x 160 mm	156 u	141,5 m^2	22,6 m^3	0,3%
		05	Chanel walls	43% / 54% / 3%	n° 40 and 41	1020 x 2605 x 90 mm	72 u	191,3 m^2	17,2 m^3	0,2%
					n° 97	1080 x 1280 x 160 mm	6 u	8,3 m^2	1,3 m^3	0,02%
					n° 98 and 99	1190 x 1765 x 160 mm	12 u	25,2 m^2	4,0 m^3	0,1%
					n° 18	1380 x 1570 x 160 mm	6 u	13,0 m^2	2,1 m^3	0,03%
		06	Attic walls	95% / 5%	n° 107	3195 x 940 x 160 mm	30 u	79,7 m^2	14,4 m^3	0,2%
					n° 106	3250 x 940 x 160 mm	9 u	12,4 m^2	4,4 m^3	0,06%
					n° 100 to 105	3420 x 940 x 160 mm	18 u	39,0 m^2	9,3 m^3	0,1%
	Cast-in-place RC	07	Cast-in-place facade walls	10% / 72% / 16% / 2%	E and W facade	6900 x 4830 x 250 mm	6 u	200,0 m^2	49,9 m^3	0,7%
					E and W facade	6900 x 2460 x 180 mm	78 u	1324,0 m^2	238,3 m^3	3,4%
					E and W facade	6900 x 2085 x 180 mm	12 u	172,6 m^2	31,1 m^3	0,4%
					N facade	4675 x 2460 x 180 mm	84 u	966,0 m^2	173,9 m^3	2,5%
					N facade	4675 x 2540 x 180 mm	6 u	71,2 m^2	12,8 m^3	0,2%

Table 6. Selected facade elements

Category	Material	Type N°	Element type	Condition	Element subtype	Element dimensions	Quantity	Area	Volume	Signifiance
Slab elements	Precast + cast-in-place RC	08	Prelam slabs with cast-in-place overlay	100%	n° 50 and 51	1940 x 3180 x 160(+50) mm	180 u	1110,5 m^2	233,2 m^3	3,4%
					n° 52	1780 x 3180 x 160(+50) mm	66 u	373,6 m^2	78,5 m^3	1,1%
					n° 55 to 57	2200 x 3140 x 160(+50) mm	792 u	5471 m^2	1148,9 m^3	16,5%
					n° 58	1940 x 3250 x 160(+50) mm	72 u	454,0 m^2	95,3 m^3	1,4%
					n° 61, 64 and 65	2200 x 3250 x 160(+50) mm	72 u	514,8 m^2	108,1 m^3	1,6%
	Cast-in-place RC	09	Cast-in-place slabs	100%	East and West Corridors - deck over ground floor	L x 1380 x 200(+80) mm	176,0 m^2	-	49,3 m^3	0,7%
					Inside Core - deck over ground floor	L x 4150 x 200(+80) mm	85,6 m^2	-	24,0 m^3	0,3%
					East and West Zones - deck over ground floor	L x 4750 x 200(+80) mm	555,0 m^2	-	155,4 m^3	2,2%
					East and West Corridors - deck over 1st floor	L x 1380 x 160(+50) mm	176,0 m^2	-	37,0 m^3	0,5%
					South Zone - deck over1st floor	L x 7330 x 650(+80) mm	344,9 m^2	-	251,8 m^3	3,6%
					East and West Zones - deck over 1st floor	L x 4750 x 160(+50) mm	646,5 m^2	-	135,8 m^3	2,0%
					Corridors - decks over 2 to 13th floors	L x 1380 x 160(+50) mm	2684,5 m^2	-	563,7 m^3	8,1%
					Inside Core - decks over 1 to 14th floors	L x 4150 x 160(+50) mm	1198,3 m^2	-	251,6 m^3	3,6%
					Corridors - deck over 14th floor	L x 1380 x 160(+50) mm	223,7 m^2	-	47,0 m^3	0,7%
					South Zone - deck over 14th floor	L x 5950 x 160(+50) mm	297,2 m^2	-	62,4 m^3	0,9%
					East and West Zones - deck over 14th floor	L x 4750 x 160(+50) mm	646,5 m^2	-	135,8 m^3	2,0%

Table 7. Selected slab elements

Category	Material	Type N°	Element type	Condition	Element subtype	Element dimensions	Quantity	Area	Volume	Signifiance
Wall elements	Prefab masonry	10	Preton walls	n.a. (probably good)	n° 81 and 82	4340 x 2410 x 150 mm	396 u	4141,9 m^2	621,3 m^3	8,9%
					n° 83	4500 x 2410 x 150 mm	66 u	715,8 m^2	107,4 m^3	1,5%
					n° 84, 85 and 87 to 89	5600 x 2410 x 150 mm	102 u	1376,6 m^2	206,5 m^3	3,0%
					n°86	3890 x 2410 x 150 mm	30 u	281,2 m^2	42,2 m^3	0,6%
					n°108 and 109	4340 x 2820 x 150 mm	36 u	440,6 m^2	66,1 m^3	1,0%
					n°110	4500 x 2820 x 150 mm	6 u	76,1 m^2	11,4 m^3	0,2%
					n°111	3890 x 2820 x 150 mm	6 u	65,8 m^2	9,9 m^3	0,1%
					n°112 and 113	5600 x 2820 x 150 mm	6 u	94,8 m^2	14,2 m^3	0,2%
	Cast-in-place RC	11	Cast-in-place interior walls	100%	1st to 14st floor	L x 2460 x 150 mm	1560 u	-	234,0 m^3	3,4%
					ground floor	L x 2540 x 150 mm	360 u	-	54,0 m^3	0,8%
Columns	Cast-in-place RC	12	Cast-in-place columns	100%	South columns	450 x 300 x 2540	72 u	-	24,7 m^3	0,4%
					East and West near-facade columns	500 x 300 x 2540	72 u	-	27,4 m^3	0,4%
					East and West interior columns	600 x 400 x 4830	12 u	-	13,9 m^3	0,2%
Staircases	Cast-in-place RC	13	Interior staircases	100%	-	r = 2,075 m, 15 steps/floor	45 u	-	517,0 m^3	7,4%

Table 8. Selected wall elements, columns and staircases

3.6 Elements factsheets

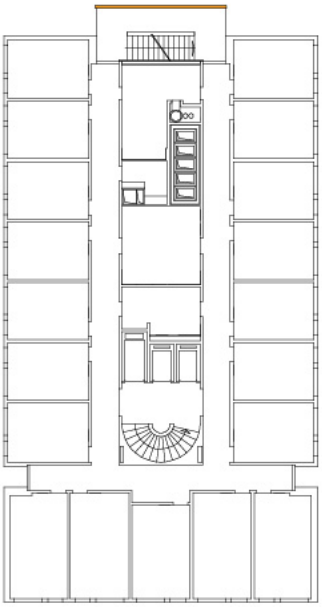
The following pages contain the factsheets of every selected element type.

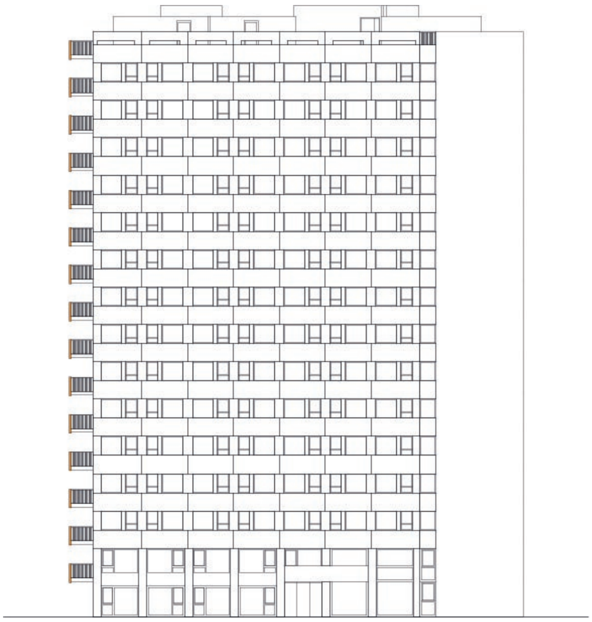
Type 01

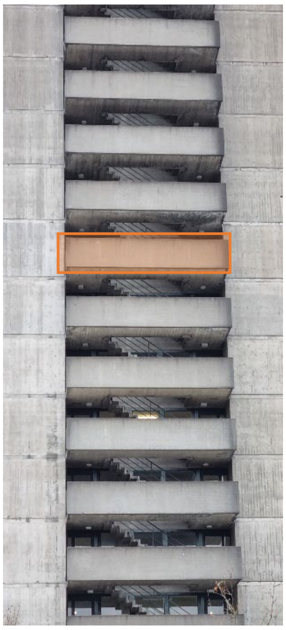
Category : Facade elements

Balcony railings

Location







Balcony railings

Color and finishing

Type 01

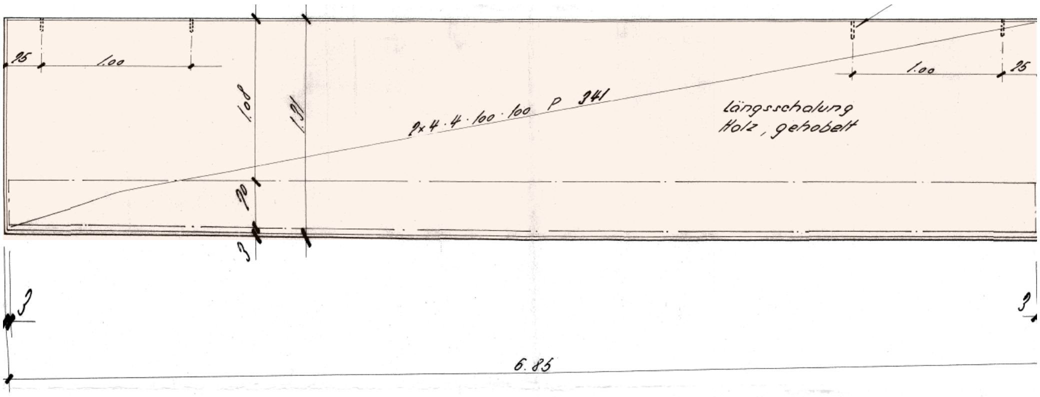
Category : Facade elements

Balcony railings

Anchor point

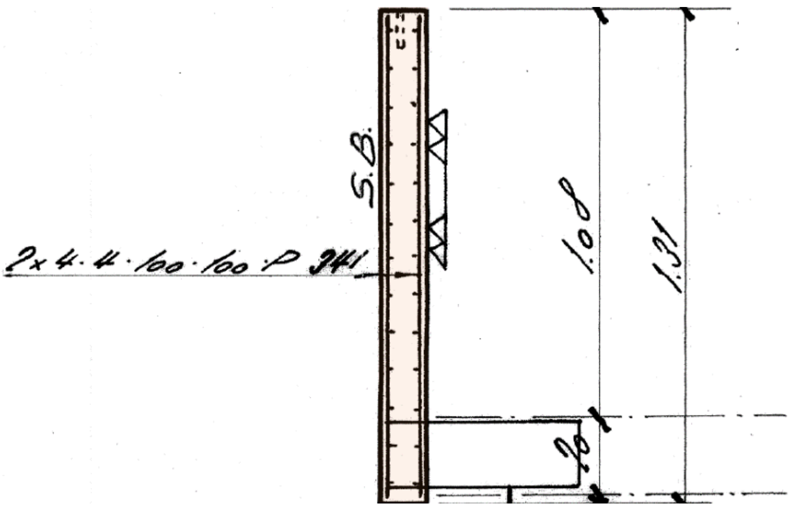
Subtype n°19, dimensions

1:50



Subtype n°19, cross-section

1 :20



Type 01 Category : Facade elements

Balcony railings

Description

Exposition	Outdoor, exposed to rain and water flow		
Color	Shade of grey, closest RAL 7023 or 7003		
Finishing	Horizontal wood plank patterns		
Actual location	N facade		
Initial function	Facade self-supporting element		
Accessibility	Easy – No further demolition required before		
Anchor points	Available		
Overlays	Type	Fixation	Thickness
	None	-	-
Connexion type	Embedded connection to the balcony slab		
Deconstruction tool	Diamond saw		

Condition and durability

Condition assessment	7 % good
	86 % acceptable
	7 % deviant
Carbonatation depth [mm]	Avg. 16 (max 19)
Toxic substance	PCB in joints

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	41 N/mm^2
Concrete young modulus	38'600 N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory					Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [u]	Weight [kg/u]	Total area [m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
19	6850 x 1310 x 120	Ø 4 S = 100	6,25	45	2692	403,8	48,5	0,7%	240	27

Additional information

Additional note

> The elements are connected to the balcony slabs by stirrups Ø 8 spaced every 250 mm.

> The carbonatation depth is lower than the 20-mm concrete cover of the rebars.

> For horizontal storage of the balcony element, support spacers should be placed every 1.8 m.

Attention point

> Vertical rebars are not anchored at the section end. The resistance is reduced in those areas.

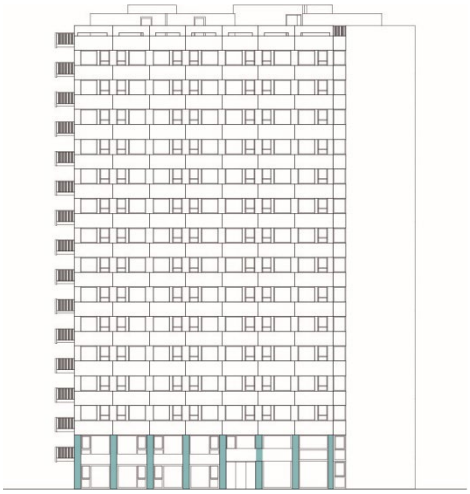
> The waterproofing joints sealant placed between the facade elements probably contain polychlorinated biphenyls (PCB). These joints must be completely removed by a specialized company. The removal can be done with a cutter, while avoiding heating the joints or producing dust.

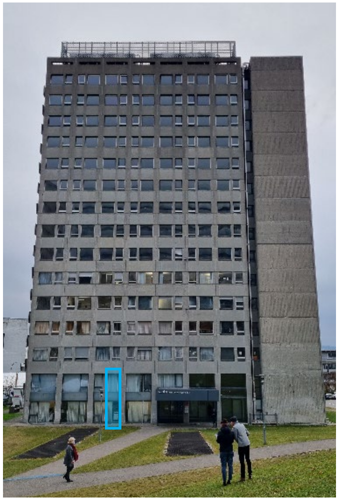
> Contamination with PCBs of the concrete neighboring the joints should be checked by further sampling. Most probably, it will be necessary to remove 1cm of the edge that was in contact with the joint.

Type 02 Category : Facade elements

Ground- and 1st-floor column coverings

Location





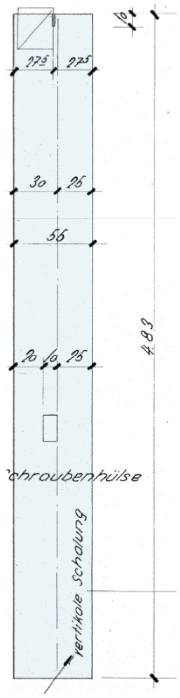
Ground- and 1st-floor column coverings

Color and finishing

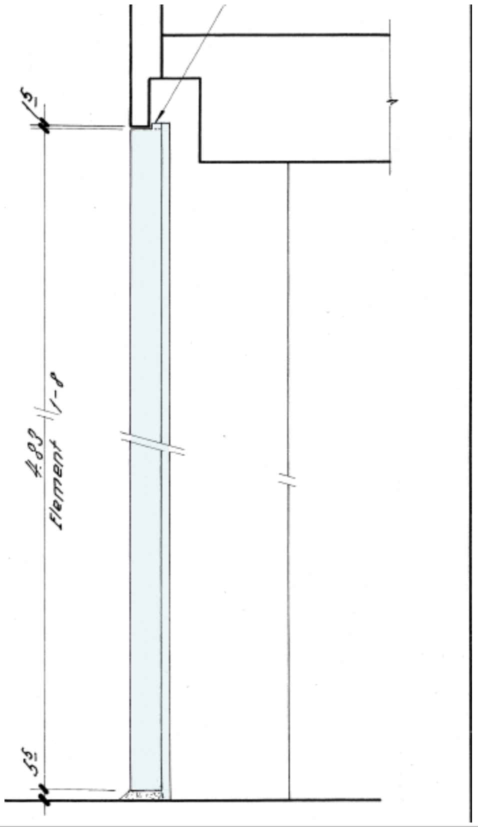
Type 02 Category : Facade elements

Ground- and 1st-floor column coverings

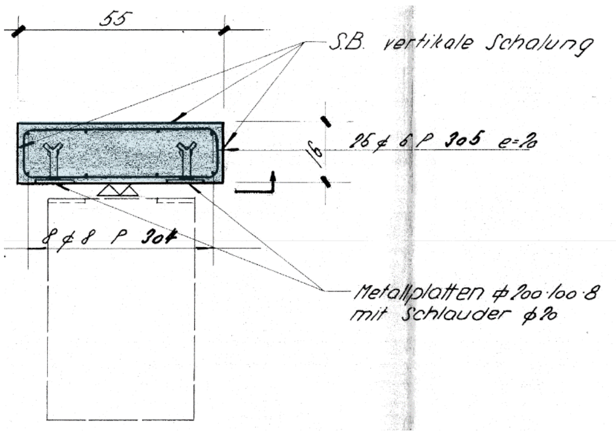
Subtype n°1, dimensions



Connexion 1 :50



Subtype n°1, cross-section 1 :20



Type 02

Category : Facade elements

Ground- and 1st-floor column coverings

Description

Exposition	Outdoor, exposed to rain and water flow		
Color	Grey with a yellowish tint, closest RAL 7044 or 9018		
Finishing	Horizontal wood plank patterns		
Actual location	E, W and S facades		
Initial function	Facade self-supporting element		
Accessibility	Moderate – One/two elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
Outside	None	-	-
Inside	Window frame	n.a.	-
Connexion type	Connected to other facade elements and foundation		
Deconstruction tool	With facade elements	With foundation	
	Cut joint sealant	Diamond saw	

Condition and durability

Condition assessment	45% good
	45% acceptable
	10% deviant
Carbonatation depth [mm]	Avg. 2-16 (max 19)
Toxic substance	PCB in joints

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	41 N/mm^2
Concrete young modulus	38'600 N/mm^2
Reinforcement tensile strength	300 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory					Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [u]	Weight [kg/u]	Total area [m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
1 to 8	4830 x 550 x 160	2 x 4 x Ø 8	10,2	66	1063	175.3	28,1	0,4%	95	11

Additional information

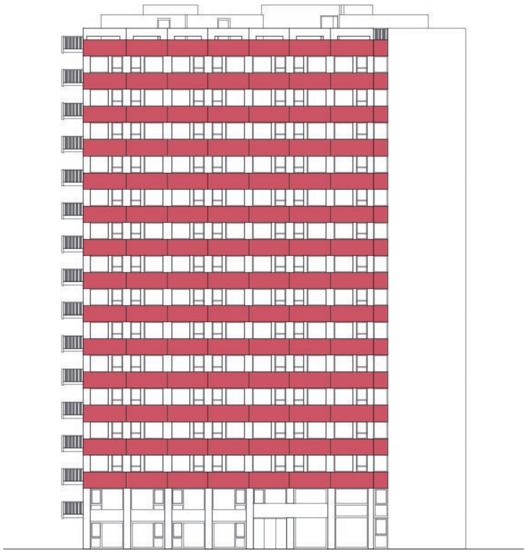
Additional note	> Stirrups of Ø 8 spaced every 250 mm are present. > The carbonatation depth is lower than the 20-mm concrete cover of the rebars. > The depth of carbonatation is less important for the elements of the southern facade.
Attention point	> The waterproofing joints sealant placed between the facade elements probably contain polychlorinated biphenyls (PCB). These joints must be completely removed by a specialized company. The removal can be done with a cutter, while avoiding heating the joints or producing dust. > Contamination with PCBs of the concrete neighboring the joints should be checked by further sampling. Most probably, it will be necessary to remove 1cm of the edge that was in contact with the joint.

Type 03

Category : Facade elements

Window apron walls

Location



Window apron wall

Color and finishing

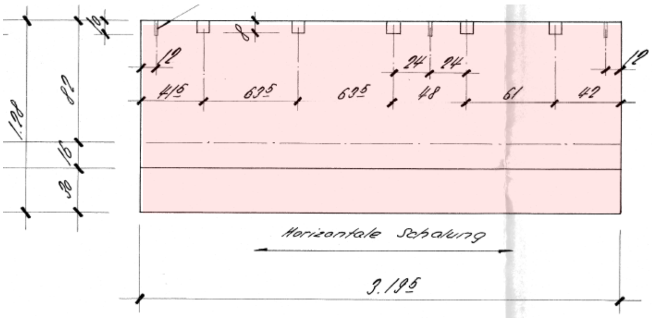
Type 03

Category : Facade elements

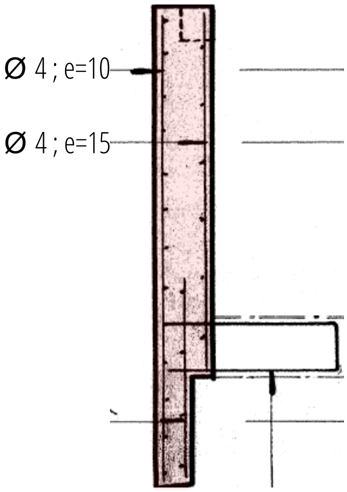
Window apron walls

Subtype n°14, dimensions

1:50

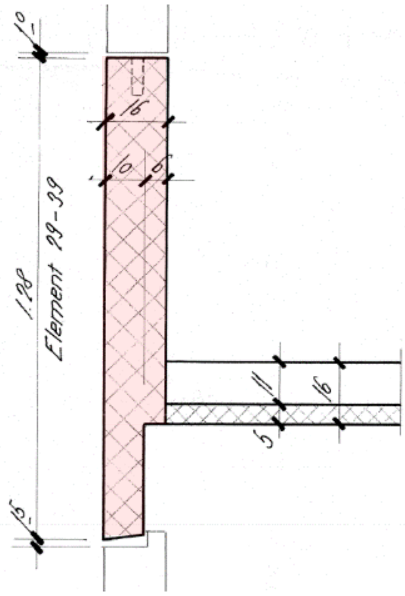


Subtype n°14, cross-section



Connection

1:20



Type 03 Category : Facade elements

Window apron walls

Description

Exposition	Outdoor, exposed to rain and water flow		
Color	Grey with a yellowish tint, closest RAL 7044		
Finishing	Horizontal wood plank patterns		
Actual location	E, W and S facades		
Initial function	Facade self-supporting element		
Accessibility	Moderate – One/two elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
From concrete	Mortar	-	5 mm
	Cork	Glued	30 mm
	Plaster	-	10 (ev. 5) mm
To surface	Wallpaper (or painting)	-	-
Connexion type	Connected to other facade elements and to slabs		
Deconstruction tool	To facade elements	To slab	
	Diam. saw	Diam. Saw or hydro-blasting	

Condition and durability

Condition assessment	43 % good
	54 % acceptable
	3 % deviant
Carbonatation depth [mm]	Avg. 2-16 (max 19)
Toxic substance	PCB; asbestos

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	41 N/mm^2
Concrete young modulus	38'600 N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory					Environmental impacts	
N°	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [u]	Weight [kg/u]	Total area [m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
39	1380 x 1280 x 160	Ø 4 S = 100-150	6,2 - 4,2	72	706,5	127,2	20,3	0,3%	63	7
14, 34, 35, 96	3195 x 1280 x 160	Ø 4 S = 100-150	6,2 - 4,2	420	1636	1717,6	274,8	4,0%	146	16
11, 30, 31	3235 x 1280 x 160	Ø 4 S = 100-150	6,2 - 4,2	117	1656	484,5	77,5	1,1%	147	17
95	3250 x 1280 x 160	Ø 4 S = 100-150	6,2 - 4,2	9	1664	37,4	6,0	0,1%	148	17
15, 17, 36, 38	3415 x 1280 x 160	Ø 4 S = 100-150	6,2 - 4,2	78	1748	341,0	54,6	0,8%	156	17
91, 92, 93, 94	3420 x 1280 x 160	Ø 4 S = 100-150	6,2 - 4,2	18	1751	78,8	12,6	0,2%	156	18
13, 16, 33, 37	3425 x 1280 x 160	Ø 4 S = 100-150	6,2 - 4,2	78	1759	342,0	54,9	0,8%	157	18
10, 12, 2, 32	3440 x 1280 x 160	Ø 4 S = 100-150	6,2 - 4,2	78	1761	343,4	55,0	0,8%	157	18

Type 03

Category : Facade elements

Window apron walls

Additional information

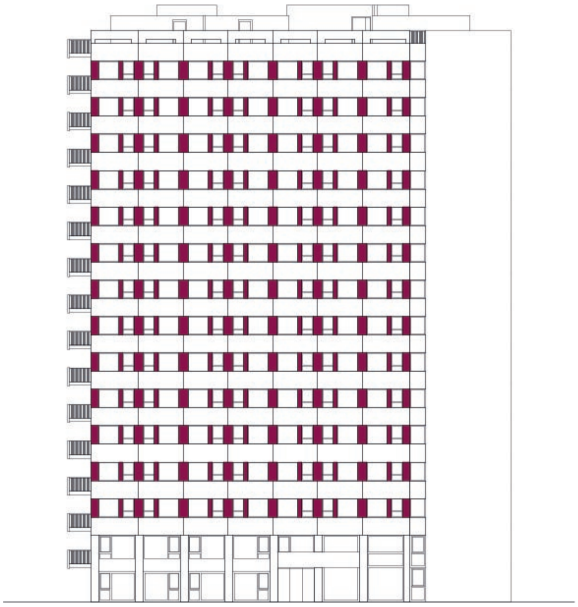
Additional note	> The carbonatation depth is lower than the 20-mm concrete cover of the rebars. > The depth of carbonatation is less important for the elements of the southern facade. > For horizontal storage of the window apron walls, support spacers should be placed every 2.8 m, and the outdoor side should be facing downwards.
Attention point	> The waterproofing joints sealant placed between the facade elements probably contain polychlorinated biphenyls (PCB). These joints must be completely removed by a specialized company. The removal can be done with a cutter, while avoiding heating the joints or producing dust. > Contamination with PCBs of the concrete neighboring the joints should be checked by further sampling. Most probably, it will be necessary to remove 1cm of the edge that was in contact with the joint. > The cork is tested negative in the four sampling areas to polycyclic aromatic hydrocarbon (PAH) but should be handled with care. > Asbestos was detected in some of the plaster covering.

Type 04

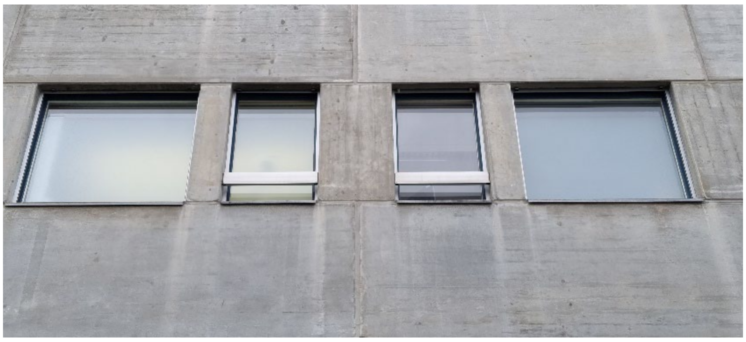
Category : Facade elements

Walls between windows

Location



Walls between windows

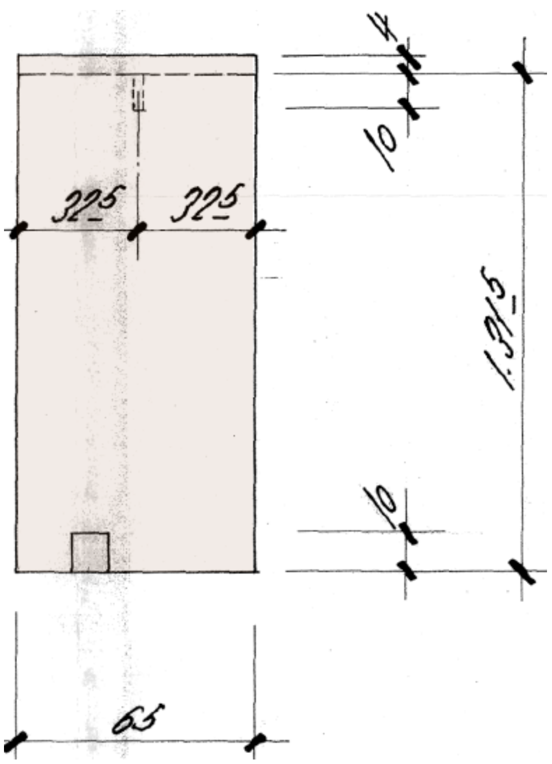


Color and finishing

Type 04 Category : Facade elements

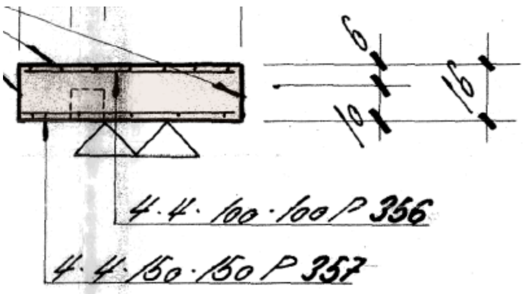
Walls between windows

Subtype n°25, dimensions



Connexion 1:20

Subtype n°25, cross-section 1:20



Type 04 Category : Facade elements

Walls between windows

Description

Exposition	Outdoor, exposed to rain and water flow		
Color	Grey with a yellowish tint, closest RAL 7044		
Finishing	Horizontal wood plank patterns		
Actual location	E, W and S facades		
Initial function	Facade self-supporting element		
Accessibility	Moderate – One/two elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
From concrete	Sagex	n.a	20 mm
To surface	Pressed wood	n.a	20 mm
Connexion type	Connected to other facade elements		
Deconstruction tool	Diam. Saw and cut joint sealants		

Condition and durability

Condition assessment	79 % good
	20 % acceptable
	1 % deviant
Carbonatation depth [mm]	Avg. 2-16 (max 19)
Toxic substance	PCB in joints

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	41 N/mm^2
Concrete young modulus	38'600 N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory					Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [u]	Weight [kg/u]	Total area [m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
26	280 x 1315 x 160	Ø 4 S = 100	1,8	741	147,3	272,8	43,7	0,6%	13	1
21 to 24	550 x 1315 x 160	Ø 4 S = 100/150	3,5–2,3	234	289,3	169,2	27,1	0,4%	26	3
27	650 x 1315 x 160	Ø 4 S = 100-150	4,1-2,8	468	341,9	400,0	64,0	0,9%	30	3
25	690 x 1315 x 160	Ø 4 S = 100-150	4,4-2,9	156	362,9	141,5	22,6	0,3%	32	4

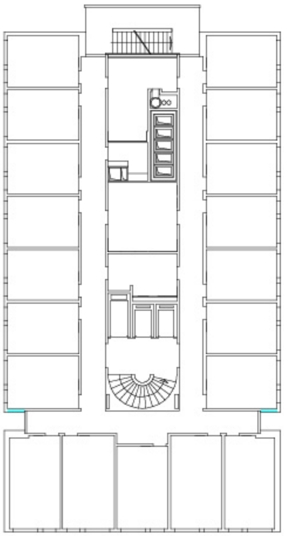
Additional information

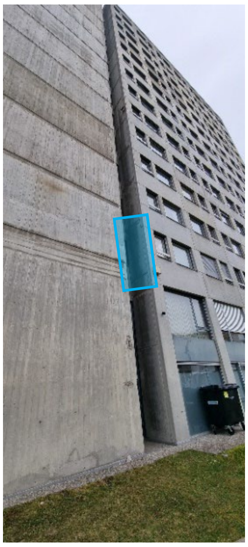
Additional note	>	The carbonatation depth is lower than the 20-mm concrete cover of the rebars.
	>	The depth of carbonatation is less important for the elements of the southern facade.
Attention point	>	The waterproofing joints sealant placed between the facade elements probably contain polychlorinated biphenyls (PCB). These joints must be completely removed by a specialized company. The removal can be done with a cutter, while avoiding heating the joints or producing dust.
	>	Contamination with PCBs of the concrete neighboring the joints should be checked by further sampling. Most probably, it will be necessary to remove 1cm of the edge that was in contact with the joint.

Type 05 Category : Facade elements

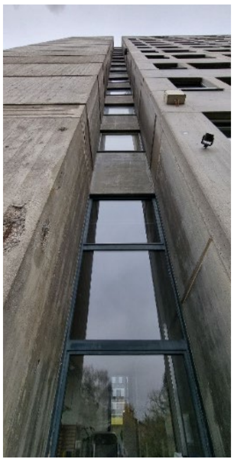
Chanel walls

Location

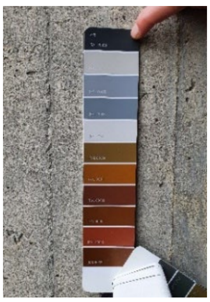




Chanel walls



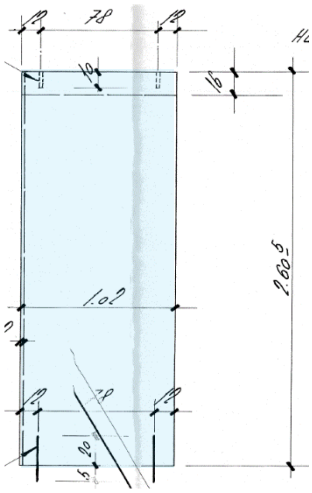
Color and finishing



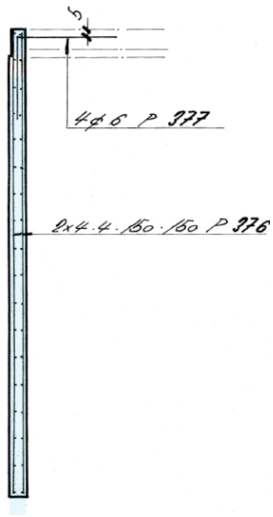
Type 05 Category : Facade elements

Chanel walls

Subtype n° 40, dimensions 1:50



Subtype n°40, cross-section 1:50



Type 05 Category : Facade elements

Chanel walls

Description

Exposition	Outdoor, exposed to rain and water flow		
Color	Grey with a yellowish tint, closest RAL 7044 or 7032		
Finishing	Horizontal wood plank patterns		
Actual location	E and W facades		
Initial function	Facade self-supporting element		
Accessibility	Moderate – One/two elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
From concrete	Plaster	-	10 mm
To surface	Wallpaper	-	-
Connexion type	To other facade elements		
Deconstruction tool	Cut joint sealants		

Condition and durability

Condition assessment	43 % good
	54 % acceptable
	3 % deviant
Carbonatation depth [mm]	Avg. 16 (max 19)
Toxic substance	PCB; asbestos

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	41 N/mm^2
Concrete young modulus	38'600 N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory					Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [u]	Weight [kg/u]	Total area [m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
40, 41	1020 x 2605 x 90	Ø 4 S = 150	5,6	72	598	191,3	17,2	0,2%	53	6
97	1080 x 1280 x 160	Ø 4 S = 100-150	6,4 - 4,4	6	553	8,3	1,3	0,02%	49	6
98, 99	1190 x 1765 x 160	Ø 4 S = 100	9,6	12	840	25,2	4,0	0,1%	75	8
18	1380 x 1570 x 160	Ø 4 S = 100-150	8,4 - 5,6	6	867	13,0	2,1	0,03%	77	9

Additional information

Additional note

> The carbonatation depth is lower than the 20-mm concrete cover of the rebars.

> The condition of elements was assessed in a least systematic way than the other facade elements. It is assumed to be proportional to the window apron wall conditions.

Attention point

> The waterproofing joints sealant placed between the facade elements probably contain polychlorinated biphenyls (PCB). These joints must be completely removed by a specialized company. The removal can be done with a cutter, while avoiding heating the joints or producing dust.

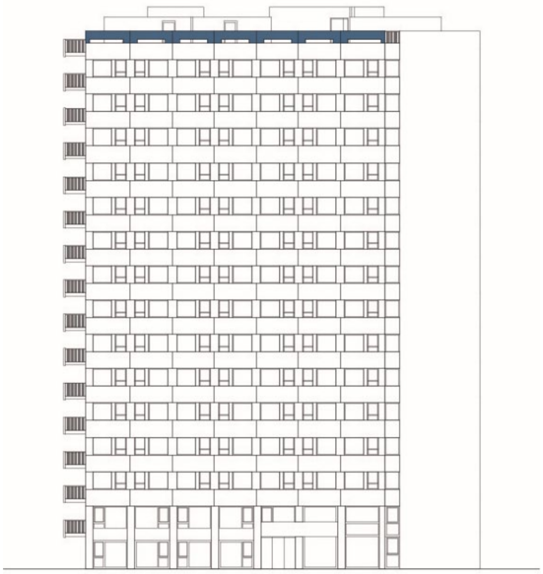
> Contamination with PCBs of the concrete neighboring the joints should be checked by further sampling. Most probably, it will be necessary to remove 1cm of the edge that was in contact with the joint.

> Asbestos was detected in some of the plaster covering.

Type 06 Category : Facade elements

Attic walls

Location



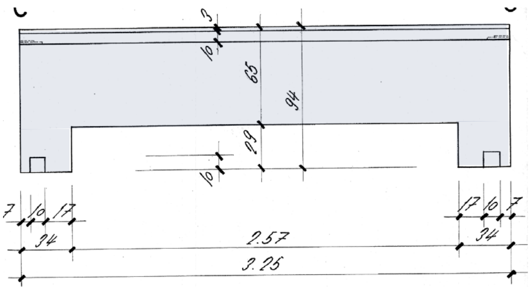

Attic walls


Color and finishing

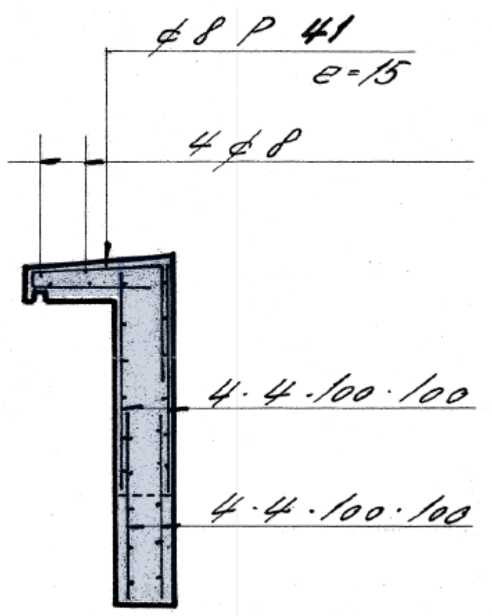

Type 06 Category : Facade elements

Attic walls

Subtype n°107, dimensions 1:50



Subtype n° 107, cross-section 1:20



Type 06 Category : Facade elements

Attic walls

Description			
Exposition	Outdoor, exposed to rain and water flow		
Color	Grey with a yellowish tint and black marks		
Finishing	Horizontal wood plank patterns		
Actual location	E, W and S facades		
Initial function	Facade self-supporting element		
Accessibility	Easy – No further demolition required before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
	None	-	-
Connexion type	Connected to window apron wall		
Deconstruction tool	Diamond saw and cut joint sealant		

Condition and durability	
Condition assessment	95 % acceptable
	5 % deviant
Carbonatation depth [mm]	Avg. 2-16 (max 19)
Toxic substance	PCB in joints

Mechanical characteristics	
Density	2500 kg/m^3
Concrete compressive strength	41 N/mm^2
Concrete young modulus	38'600 N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory					Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [u]	Weight [kg/u]	Total area [m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
107	1020 x 2605 x 160	Ø 4 S = 100	4,1	30	1201	79,7	14,4	0,2%	107	12
106	1080 x 1280 x 160	Ø 4 S = 100	4,1	9	1222	12,4	4,4	0,1%	109	12
100 to 105	1380 x 1570 x 160	Ø 4 S = 100	4,1	18	1286	39,0	9,3	0,1%	114	13

Additional information

Additional note

> The carbonatation depth is lower than the 20-mm concrete cover of the rebars.
> The depth of carbonatation is less important for the elements of the southern facade.
> For horizontal storage of the attic walls, support spacers should be placed every 2.5 m, and the outdoor side should be facing downwards.

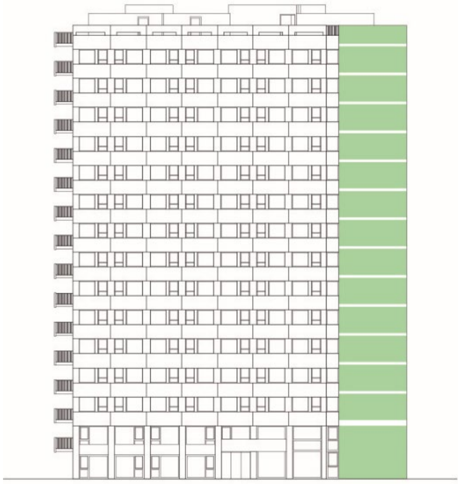
Attention point

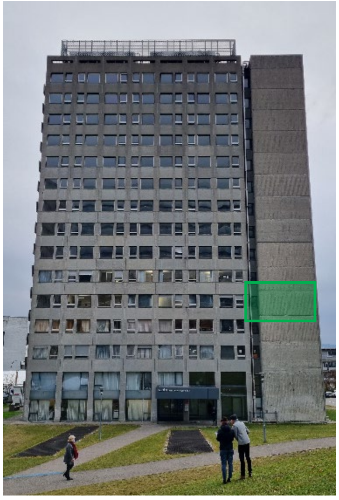
> The waterproofing joints sealant placed between the facade elements probably contain polychlorinated biphenyls (PCB). These joints must be completely removed by a specialized company. The removal can be done with a cutter, while avoiding heating the joints or producing dust.
> Contamination with PCBs of the concrete neighboring the joints should be checked by further sampling. Most probably, it will be necessary to remove 1cm of the edge that was in contact with the joint.

Type 07 Category : Facade elements

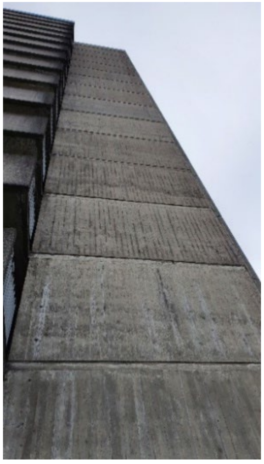
Cast-in-place facade walls

Location





Cast-in-place facade walls



Color and finishing

Type 07 Category : Facade elements

Cast-in-place facade walls

Description

Exposition	Outdoor, exposed to rain and water flow		
Color	Shades of grey, closest RAL 7044 or 7032		
Finishing	Horizontal wood plank patterns		
Actual location	E, W and N facades		
Initial function	Facade load-bearing element		
Accessibility	Moderate – One/two elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
From concrete	Cork	Glued	60 mm
	Masonry brick	-	60 mm
	Mortar or plaster	-	10 mm
To surface	Wallpaper	-	-
Connexion type	Connected slabs and facade elements		
Deconstruction tool	Diamond saw or hydro-blasting		

Condition and durability

Condition assessment	10 % Good
	72 % Acceptable
	16 % Deviant
	2 % bad
Carbonatation depth [mm]	Avg. 16 (max 19)
Toxic substance	asbestos

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	69 N/mm^2
Concrete young modulus	41'500 N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory					Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm/m]	Quantity [u]	Weight [kg/u]	Total area [m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
E and W facade	6900 x 4830 x 250	Ø 10 - 12 S = 250 - 150	24,8 – 59,6	6	20786	200,0	49,9	0,7%	1850	208
E and W facade	6900 x 2460 x 180	Ø 8 – 10 S = 250 - 150	11,4 – 29,8	78	7638	1324,0	238,3	3,4%	680	76
E and W facade	6900 x 2085 x 180	Ø 8 – 10 S = 250 - 150	11,4 – 29,8	12	6474	172,6	31,1	0,4%	576	76
N facade	4675 x 2460 x 180	Ø 8 - 10 S = 250 - 150	11,4 – 29,8	84	5175	966,0	173,9	2,5%	461	52
N facade	4675 x 2540 x 180	Ø 8 – 10 S = 250 - 150	11,4 – 29,8	6	5343	71,2	12,8	0,2 %	476	53

Type 07 Category : Facade elements

Cast-in-place facade walls

Additional information

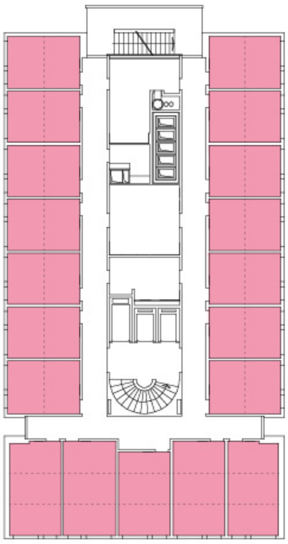
Additional note	>	Cast-in-place walls are reinforced with Ø8 transversal rebars spaced every 150/250 mm depending the areas.
	>	The carbonatation depth is lower than the 30-mm concrete cover of the rebars.
	>	For horizontal storage of the cast-in-place facade walls, the outdoor side should be facing downwards.
Attention point	>	Only two samples were analyzed to determine the strength of the concrete.
	>	The cork is tested negative in the four sampling areas to polycyclic aromatic hydrocarbon (PAH) but should be handled with care.
	>	Asbestos was detected in some of the plaster covering.

Type 08

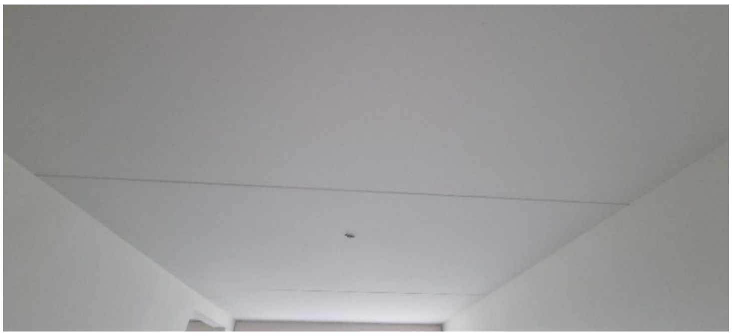
Category : Slab elements

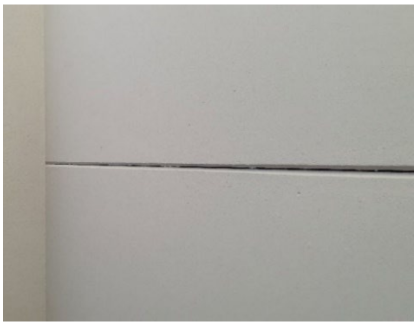
Prelam slabs with cast-in-place overlay

Location



Prelam slabs with cast-in-place overlay

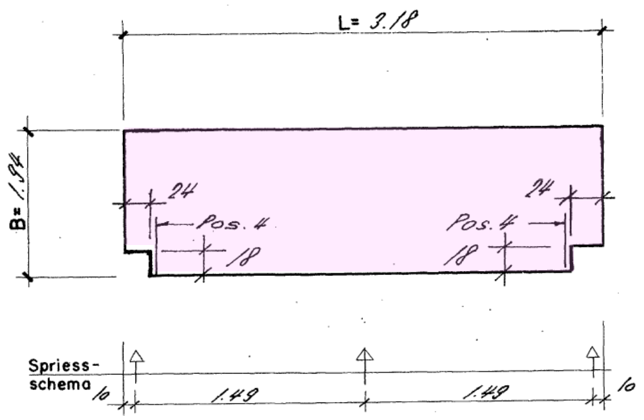




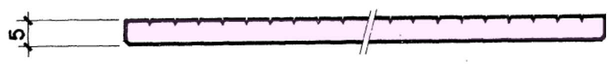
Type 08 Category : Slab elements

Prelam slabs with cast-in-place overlay

Subtype n° 50, dimensions 1:50



Subtype n°50, cross-section (only prelam slab) 1:50



Type 08 Category : Slab elements

Prelam slabs with cast-in-place overlay

Description

Exposition	Inside, not exposed		
Color	n.a		
Finishing	White paint on the bottom side		
Actual location	Floor 2nd to 13th		
Initial function	Slab load-bearing element		
Accessibility	Difficult – three & more elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
From upper surface	PVC flooring	Glued	5 mm
To concrete	Screed	-	50 mm
From concrete	None + suspended ceiling or		-
To lower surface	Plaster + painting		2-3 mm
Connexion type	Prelams connected through cast-in-place overlay. Prelams connected to wall		
Deconstruction tool	Diamond saw		

Condition and durability

Condition assessment	100% good
Carbonatation depth [mm]	< 1,0
Toxic substance	None

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	25 N/mm^2
Concrete young modulus	33'800 N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory					Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [u]	Weight [kg/u]	Total area [m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
50, 51	1940 x 3180 x 160 (+screed of 50)	14 x Ø 5	13,0	180	3239	1110,5	233,2	3,4%	288	32
52	1780 x 3180 x 160 (+screed of 50)	13 x Ø 5	12,1	66	2972	373,6	78,5	1,1%	264	30
55 to 57	2200 x 3140 x 160 (+screed of 50)	16 x Ø 5	14,9	792	3627	5471	1148,9	16,5%	323	36
58	1940 x 3250 x 160 (+screed of 50)	14 x Ø 5	13,0	72	3310	454,0	95,3	1,4%	295	33
61, 64, 65	2200 x 3250 x 160 (+screed of 50)	16 x Ø 5	14,9	72	3754	514,8	1081	1,6%	334	38

Type 08 Category : Slab elements

Prelam slabs with cast-in-place overlay

Additional information

Additional note	>	The cores to determine the strength of the concrete, included the prelam slab and the cast-in-place overlay. Their strength is estimated to be similar and the bond between the layers is assumed to be good.
	>	The weight and the volume include the thickness of the screed.
Attention point	>	The toxicity reports [G, H, I] assume that the glue of the PVC flooring is free of asbestos.

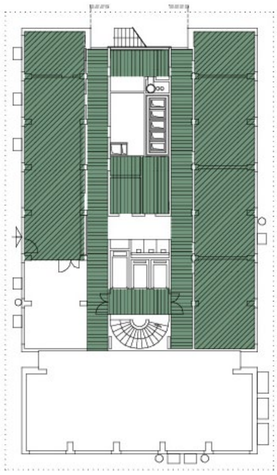
Type 09

Category : Slab elements

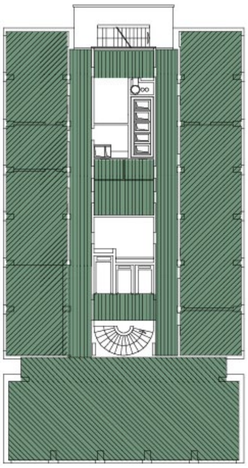
Cast-in-place slabs

Location

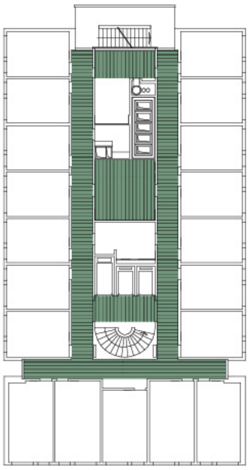
Ground-floor



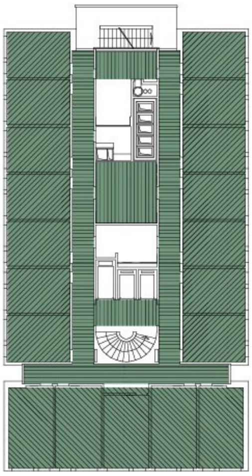
1st-floor



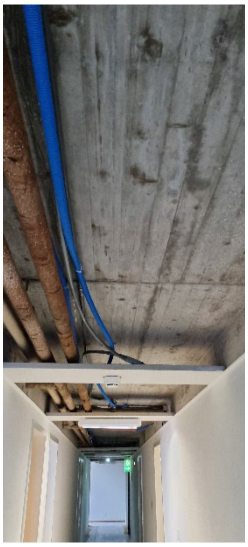
2 to 13 floors



14st floor



Cast-in-place slabs



Color and finishing

Type 09 Category : Slab elements

Cast-in-place slabs

Description

Exposition	Inside, not exposed		
Color	Shade of grey, closest RAL 7044		
Finishing	Horizontal wood plank patterns		
Actual location	All floor		
Initial function	Slab load-bearing element		
Accessibility	Difficult – three & more elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
From upper surface	PVC flooring	Glued	5 mm
To concrete	Cement screed	-	50-80 mm
From concrete	None /cork + susp. ceiling		-
To lower surface	Plaster + painting		2-3 mm
Connexion type	Monolithic connexions with slabs and walls		
Deconstruction tool	Diamond saw and hydro-blasting		

Condition and durability

Condition assessment	100% good
Carbonatation depth [mm]	< 1,0
Toxic substance	None

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	25 MPa
Concrete young modulus	33'800 MPa
Reinforcement tensile strength	450 MPa
Reinforcement young modulus	205'000 MPa

Element	Geometry characteristics			Inventory				Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resiststance [kNm/m]	Quantity [m^2]	Weight [kg/ m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/m^2]	Conventional demolition [kgCO2-eq/m^2]
East and West Corridors - deck over ground floor	1380 x L x 200 (+screed of 80)	Ø 8 - 8 S =300 - 300	10,6 – 10,6	176	700	49,3	0,7%	62	7
Inside Core - deck over ground floor	4150 x L x 200 (+screed of 80)	Ø 10 - 8 S = 200 - 300	24,8 – 10,6	85,6	700	24,0	0,3%	62	7
East and West Zones - deck over ground floor	4750 x L x 200 (+screed of 80)	Ø 12 - 8 S = 200 – 200/300	35,7 – 15,9 / 10,6	555	700	155,4	2,2%	62	7
East and West Corridors - deck over 1st floor	1380 x L x 160 (+screed of 50)	Ø 8 - 8 S = 150/300 - 300	16,9 / 8,5 – 12,7	176	525	37,0	0,5%	47	5
South Zone - deck over1st floor	7330 x L x 650 (+screed of 80)	Ø 20 - 12 S = 200 - 200	8,1 – 11,6	345	1825	251,8	3,6%	162	18

Type 09

Category : Slab elements

Cast-in-place slabs

Element	Geometry characteristics			Inventory				Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resiststance [kNm/m]	Quantity [m^2]	Weight [kg/ m^2]	Volume [m^3]	Significance	Initial production [kgCO2-eq/m^2]	Conventional demolition [kgCO2-eq/m^2]
East and West Zones - deck over 1st floor	4750 x L x 160 (+screed of 50)	Ø 12 - 8 S = 150/300 - 150	38,1 / 19,1 – 16,9	647	525	135,8	2,0%	47	5
Corridors - decks over 2 to 13th floors	1380 x L x 160 (+screed of 50)	Ø 10 / 8 S = 200 - 300	12,7 – 8,5	2685	525	563,7	8,1%	47	5
Inside Core - decks over 1 to 14th floors	4150 x L x 160 (+screed of 50)	Ø 10 - 8 S = 150 - 300	26,5 – 8,5	1198	525	251,6	3,6%	47	5
Corridors - deck over 14th floor	1380 x L x 160 (+screed of 50)	Ø 8/12 - 8 S = 100 - 300	25,4 / 57,2 – 8,5	224	525	47,0	0,7%	47	5
South Zone - deck over 14th floor	5950 x L x 160 (+screed of 50)	Ø 12 - 8 S = 150 - 300	38,1 – 6,5	297	525	62,4	0,9%	47	5
East and West Zones - deck over 14th floor	4750 x L x 160 (+screed of 50)	Ø 15 - 8 S = 150 - 300	59,6 – 8,5	647	525	135,8	2,0%	47	5

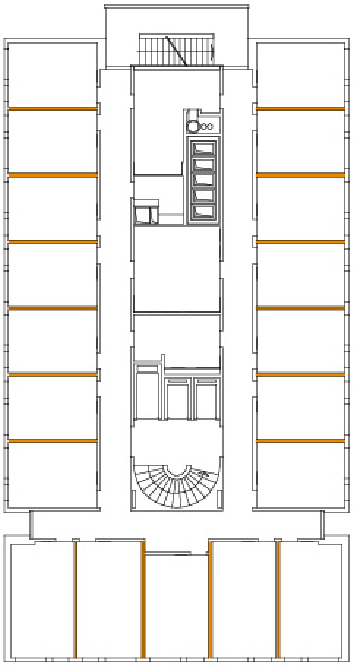
Additional information

Additional note	>	For horizontal storage of cast-in-place slabs, support spacers should be placed every 5 m
	>	Cork isolation is used under the roof slab.
	>	The weight and the volume include the thickness of the screed.
Attention point	>	The cork is tested negative in the four sampling areas to polycyclic aromatic hydrocarbon (PAH) but should be handled with care.
	>	The toxicity reports [G, H, I] assume that the glue of the PVC flooring is free of asbestos.

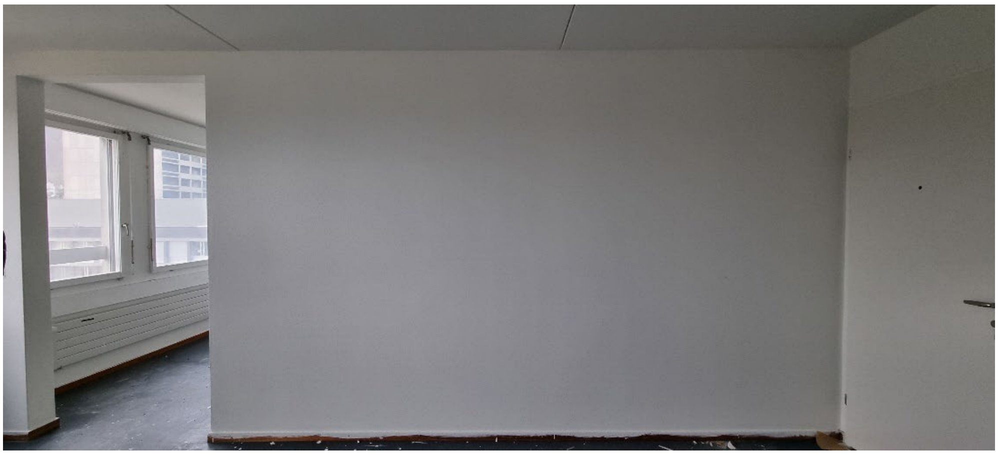
Type 10 Category : Wall elements

Preton walls

Location



Preton wall

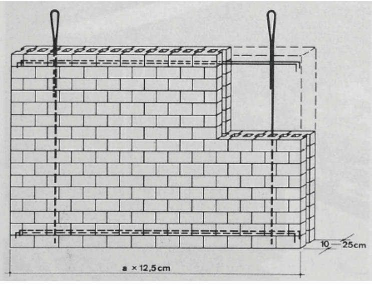


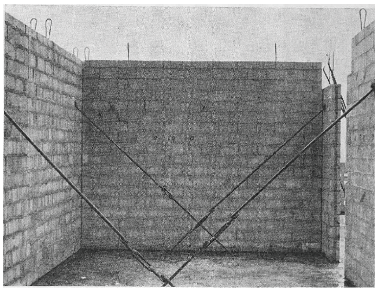
Type 10

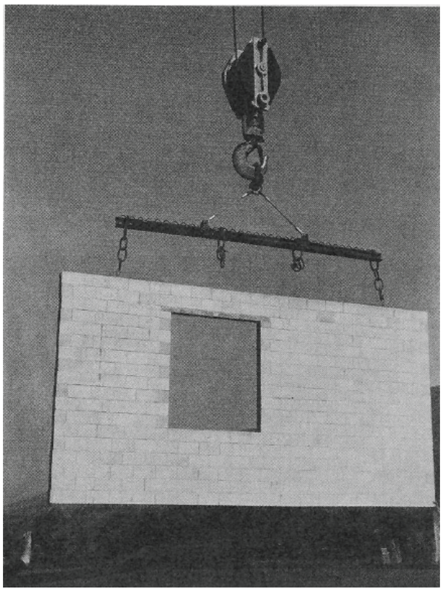
Category : Wall elements

Preton walls

Preton wall

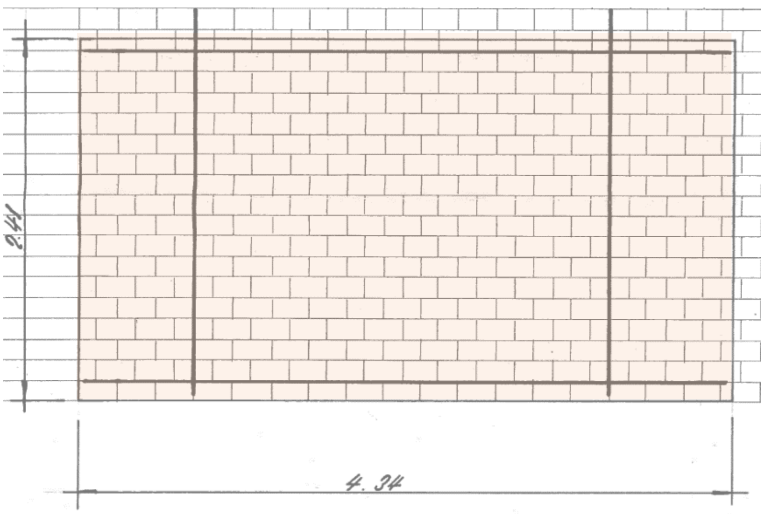






Subtype n° 82, dimensions

1:50



Type 10 Category : Wall elements

Preton walls

Description

Exposition	Inside, not exposed		
Color	n.a		
Finishing	n.a		
Actual location	Floor 2nd to 13th		
Initial function	Wall load-bearing element		
Accessibility	Difficult – three & more elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
	Wallpaper	Glued	-
Connexion type	Mortar bed		
Deconstruction tool	Saw		

Condition and durability

Condition assessment	n.a. (prob. good)
Carbonatation depth	n.a.
Toxic substance	None

Mechanical characteristics

Density	900 kg/m^3
Masonry compressive strength	n.a. N/mm^2
Masonry young modulus	n.a. N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory					Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [m^2]	Weight [kg/ u]	Total area [m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
81, 82	4340 x 2410 x 150	Ø 14	n.a.	396	1412	4141,9	621	8,9%	352	13
83	4500 x 2410 x 150	Ø 14	n.a.	66	1464	715,8	107	1,5%	365	13
84, 85, 87 to 89	5600 x 2410 x 150	Ø 14	n.a.	102	1822	1376,6	207	3,0%	454	16
86	3890 x 2410 x 150	Ø 12	n.a.	30	1266	281,2	42,2	0,6%	315	11
108, 109	4340 x 2820 x 150	Ø 14	n.a.	36	1652	440,6	66,1	1,0%	411	15
110	4500 x 2820 x 150	Ø 14	n.a.	6	1713	76,1	11,4	0,2%	427	15
111	3890 x 2820 x 150	Ø 12	n.a.	6	1481	65,8	9,9	0,1%	369	13
112, 113	5600 x 2820 x 150	Ø 14	n.a.	6	2132	94,8	14,2	0,2%	531	19

Additional information

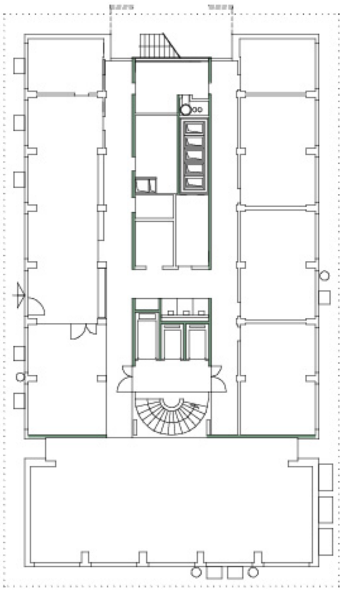
Additional note	> See historical paper on prefabricated masonry wall [20]. > The condition of these walls could not be assessed as they were covered by wallpaper. However, it is assumed to be good.
Attention point	-

Type 11 Category : Wall elements

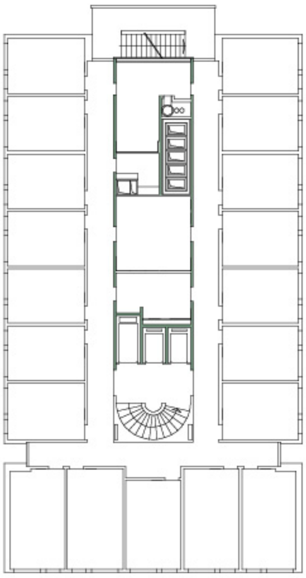
Cast-in-place interior walls

Location

Ground-floor



All other floors



Cast-in-place interior wall

Ground-floor

Type 11

Category : Wall elements

Cast-in-place interior walls

Description

Exposition	Inside, not exposed		
Color	Shade of grey or white painted		
Finishing	Horizontal wood plank patterns or crepis		
Actual location	All floors		
Initial function	Wall load-bearing element		
Accessibility	Difficult – three & more elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
From concrete	Mortar	-	10 mm
To surface	Wallpaper	Glued	-
Connexion type	Connected to cast-in-place slabs		
Deconstruction tool	Diamond saw or hydro-blasting		

Condition and durability

Condition assessment	100% good
Carbonatation depth [mm]	Avg. 8 (max 20)
Toxic substance	None

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	69 N/mm^2
Concrete young modulus	41'500 N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry			Inventory				Environmental impacts	
Subtype	Dimensions (L x H x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm/m]	Quantity [m^2]	Weight [kg/ m^2]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/ m^2]	Conventional demolition [kgCO2-eq/ m^2]
1st to 14th floor	L x 2460 x 150	Ø 8 S = 250	9,5	1560	375	234	3,4%	33	4
Ground floor	L x 2540 x 150	Ø 8 S = 250	9,5	360	375	54	0,8%	33	4

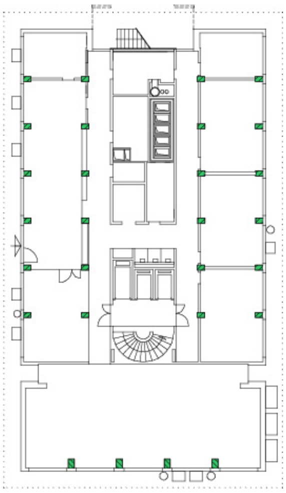
Additional information

Additional note	>	The only core tested for the cast-in-place interior walls showed an abnormally low result. The strength of the concrete was estimated to be equal to the one of the cast-in-place facade walls since they were probably cast at the same time.
Attention point	-	

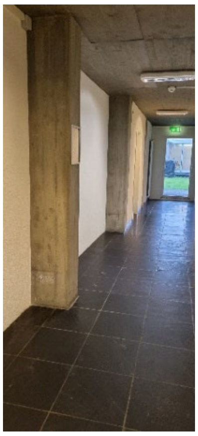
Type 12 Category : Columns

Cast-in-place columns

Location



Cast-in-place columns

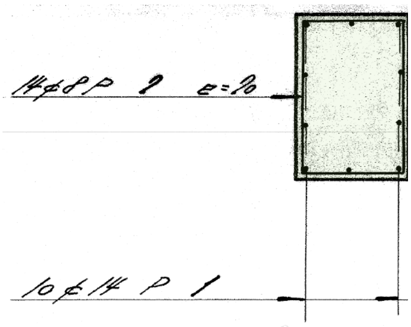


Color and finishing

Type 12 Category : Columns

Cast-in-place columns

East and west near-facade columns, cross-section 1:20



Type 12 Category : Columns

Cast-in-place columns

Description

Exposition	Inside, not exposed		
Color	Shade of grey, closest RAL 7044		
Finishing	Horizontal wood plank patterns		
Actual location	Ground- and 1st-floor		
Initial function	Column load-bearing element		
Accessibility	Difficult – three & more elements to dismantle before		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
	None	-	-
Connexion type	Connected with slabs		
Deconstruction tool	Diamond saw or hydro-blasting		

Condition and durability

Condition assessment	100% good
Carbonatation depth [mm]	Avg. 8 (max 20)
Toxic substance	None

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	69 N/mm^2
Concrete young modulus	41’500 N/mm^2
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205’000 N/mm^2

Element	Geometry			Inventory				Environmental impacts	
Subtype	Dimensions (W x L x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [u]	Weight [kg/u]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
East and west near-facade	450 x 300 x 2540	6 x Ø 14	43,8	72	857	24,7	0,4%	76	9
East and west interior	500 x 300 x 2540	6 x Ø 14 / 8 x Ø 12	43,8 / 42,9	72	953	27,4	0,4%	85	10
South	600 x 400 x 4830	10 x Ø 14	97,3	12	2898	13,9	0,2%	258	29

Additional information

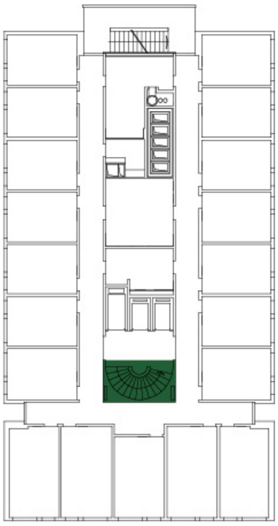
Additional note	> Stirrups of Ø 8 spaced every 200 mm are present in all columns. > No core was tested from the columns. The carbonatation depth and the concrete resistance are supposed equal to the results of cast-in-place interior walls.
Attention point	-

Type 13

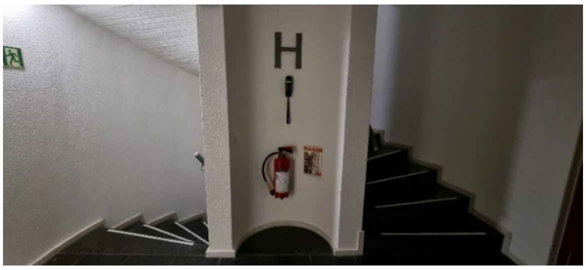
Category : Staircases

Interior staircases

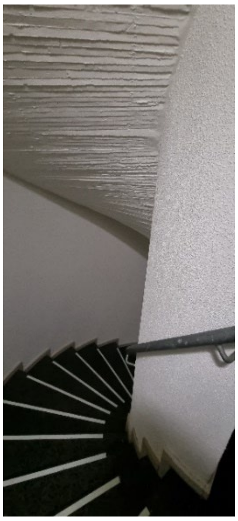
Location

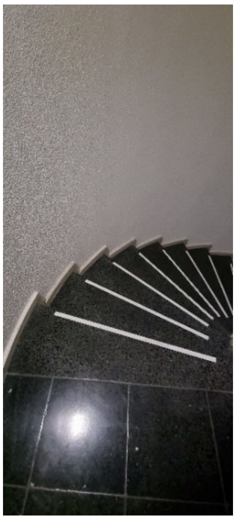


Indoor staircase



Color and finishing





Type 13 | Category : Staircases

Interior staircases

Description

Exposition	Inside, not exposed		
Color	n.a		
Finishing	n.a		
Actual location	All floors		
Initial function	Staircase		
Accessibility	Very difficult – All building most be dismantled		
Anchor points	Not available		
Overlays	Type	Fixation	Thickness
Upper surface	Floor tiles	Glued	-
Lower surface	White painting	-	-
Connexion type	Connected to cast-in-place slabs		
Deconstruction tool	Diamond saw or hydro-blasting		

Condition and durability

Condition assessment	100% good
Carbonatation depth [mm]	Avg. 8 (max 20)
Toxic substance	None

Mechanical characteristics

Density	2500 kg/m^3
Concrete compressive strength	n.a.
Concrete young modulus	n.a.
Reinforcement tensile strength	450 N/mm^2
Reinforcement young modulus	205'000 N/mm^2

Element	Geometry characteristics			Inventory				Environmental impacts	
Subtype	Dimensions (L x H x T) [mm]	Reinforcement [mm]	Cross-section resistance [kNm]	Quantity [m^2]	Weight [kg/ u]	Total volume [m^3]	Significance	Initial production [kgCO2-eq/u]	Conventional demolition [kgCO2-eq/u]
Indoor circular staircases	r = 2.075 m 15 steps/floor	n.a.	n.a.	45	28720	517	7,4 %	2556	287

Additional information

Additional note	>	The carbonatation depth is estimated to be equal to the one of cast-in-place interior walls.
Attention point	-	

4 Conclusion

This report presents the methodology followed to establish the resource assessment of precast and cast-in-place load-bearing concrete structures of buildings such as the Stadtspital Triemli Personalhäuser. Most of the elements constituting the load-bearing system of the Triemli Personalhäuser were found to be in a good or acceptable condition, which reflects positively on the ability of the concrete elements to be reused. Moreover, this construction system is made up of repetitive elements that can easily be classified into types and subtypes, facilitating their inventory and the transmission of information through factsheets. This document should serve as a base for designing and planning future reuse applications for the concrete elements extracted when deconstructing the Triemli Personalhäuser. The information presented here will help the planners to prioritize the reuse strategy on the elements in the best conditions, with the largest volume share and thus with the largest embodied global warming potential.

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Annex 1 – Location of element types

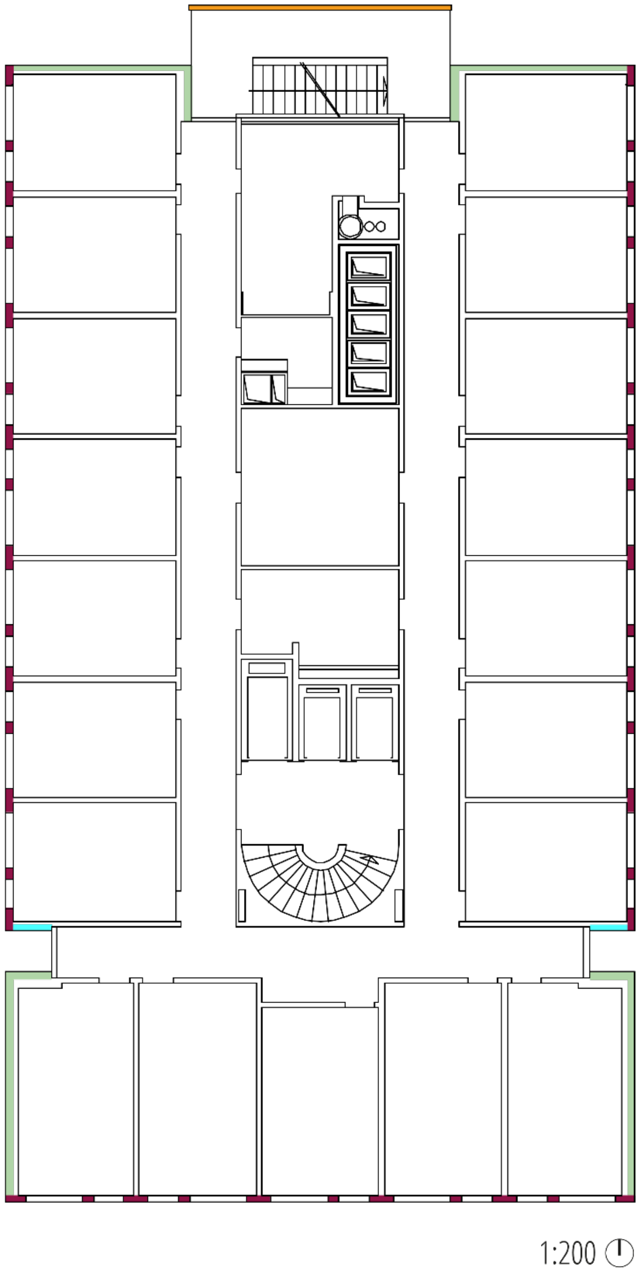
Precast RC

- 01 - Balcony railings
- 02 - Ground- and 1st-floor column coverings
- 03 - Window apron walls
- 04 - Walls between windows
- 06 - Attic walls

Cast-in-place RC

- 07 - Cast-in-place facade walls

Figure 15. Location of facade element (1/2)



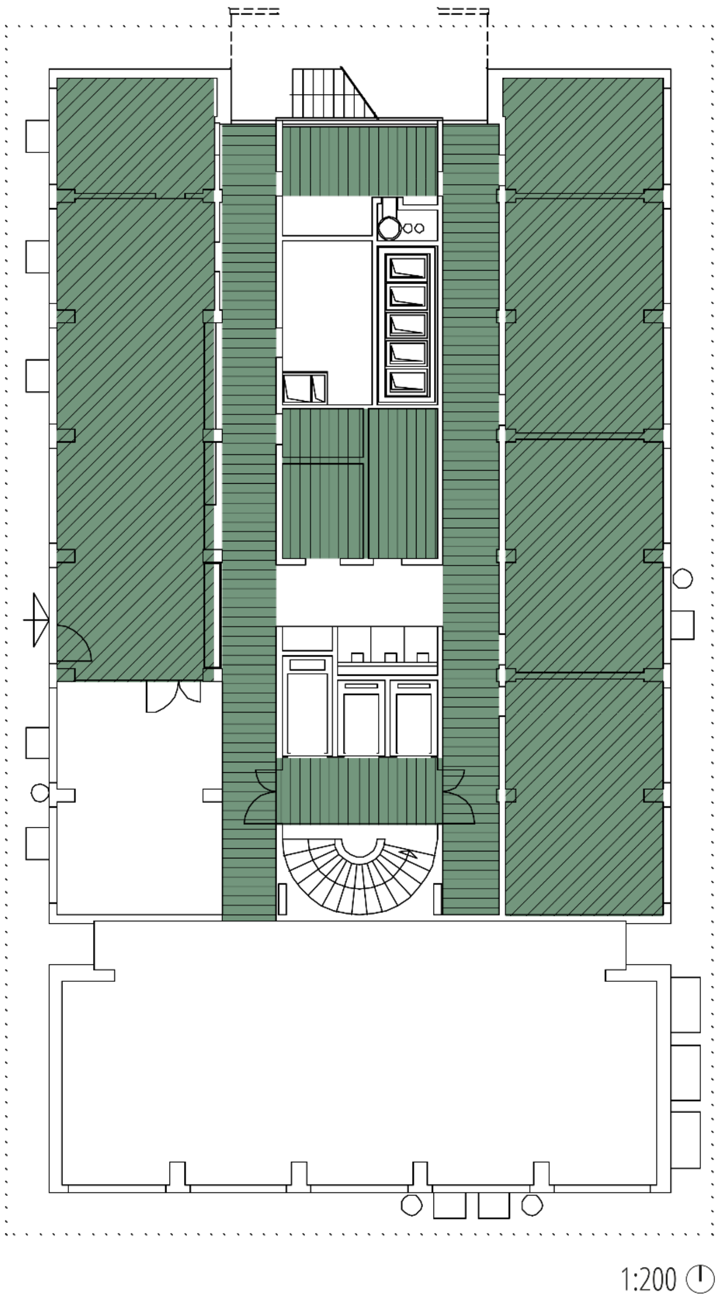
Precast RC

- 01 - Balcony railings
- 04 - Walls between windows
- 05 - Chanel walls

Cast-in-place RC

- 07 - Cast-in-place facade walls

Figure 16. Location of facade element (2/2) – 3rd to 13rd floor



Cast-in-place RC

09 - Cast-in-place slabs

Corridor zones

Inside-core zones

East/West zones

Figure 17. Location of slab element (1/4) – Slabs over the ground floor

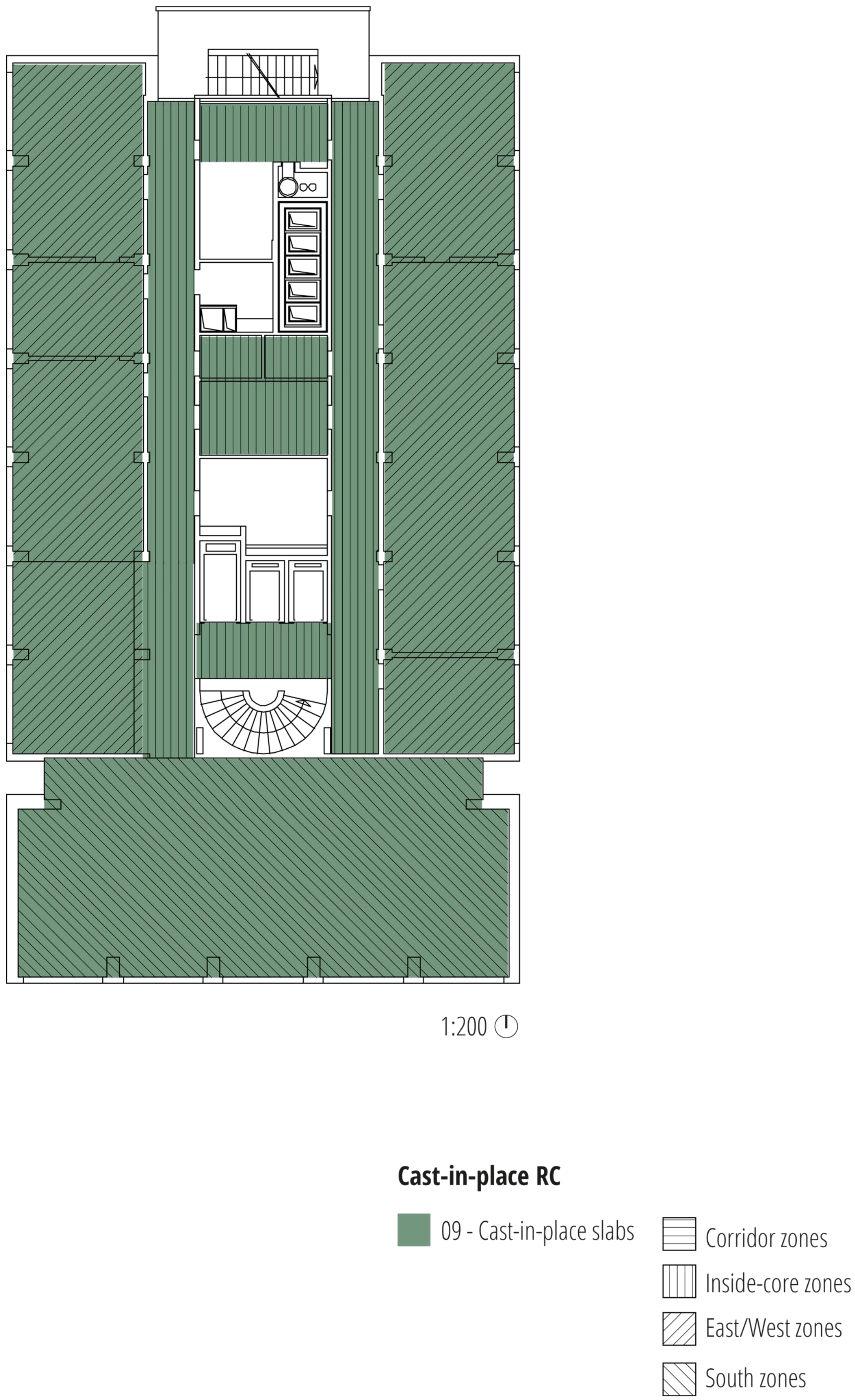
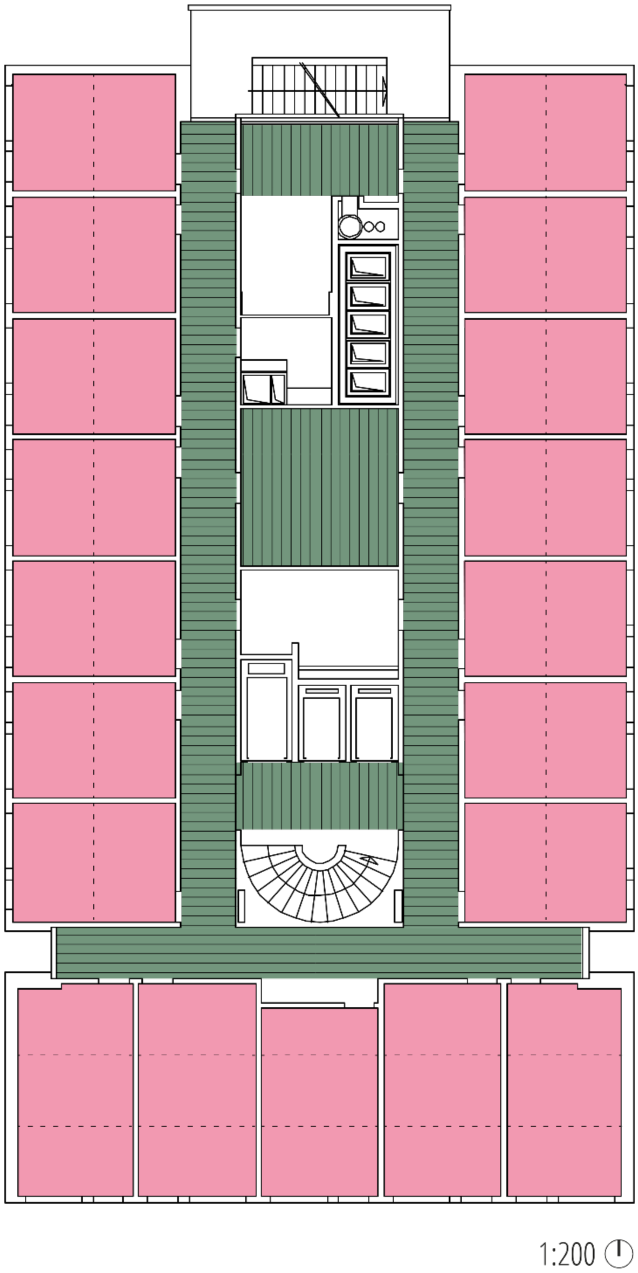


Figure 18. Location of slab element (2/4) – Slabs over the 1st floor



Precast RC

08 - Prelam slabs with cast-in-place overlays

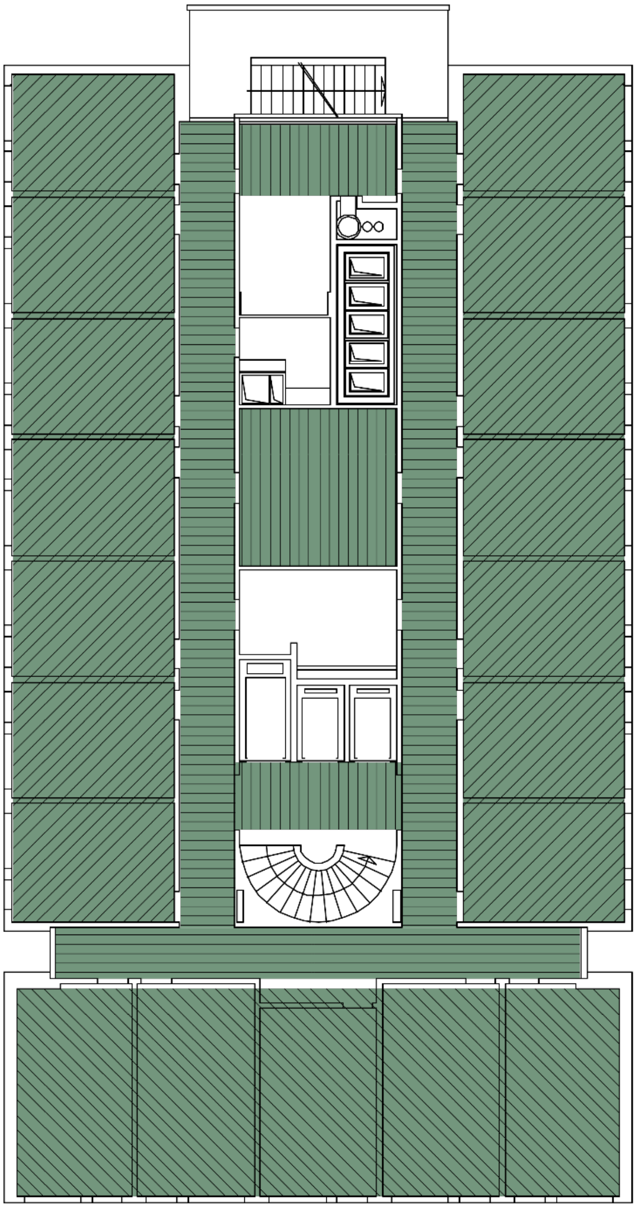
Cast-in-place RC

09 - Cast-in-place slabs

Corridor zones

Inside-core zones

Figure 19. Location of slabs element (3/4) – Slabs over floors 3 to 13

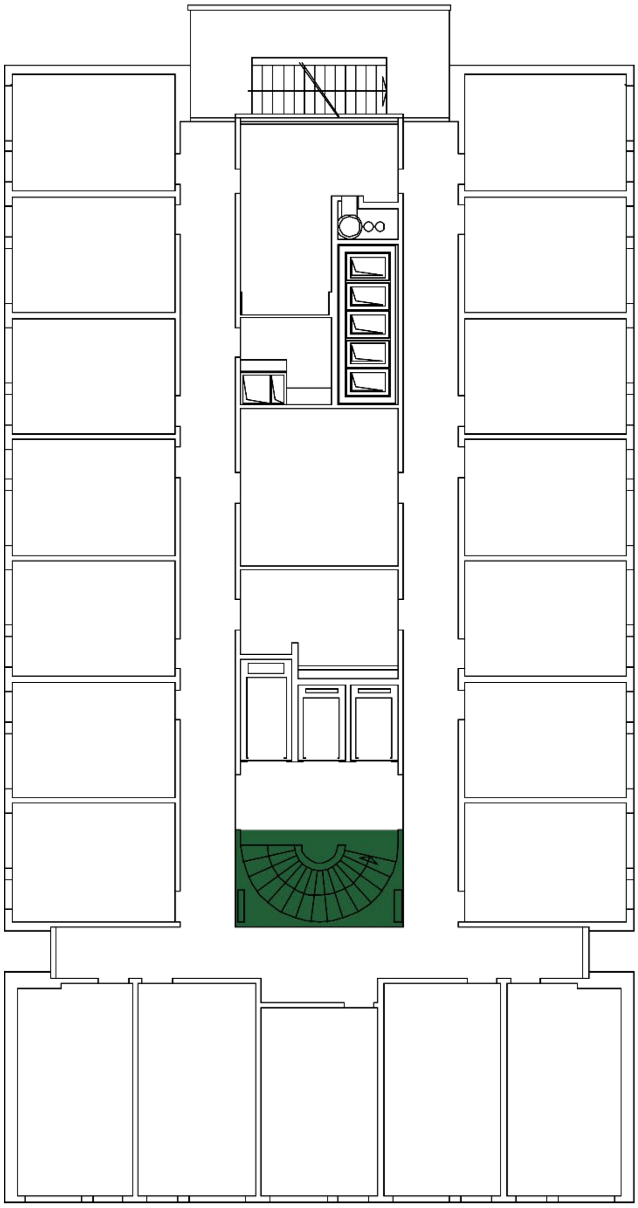


1:200

Cast-in-place RC

- 09 - Cast-in-place slabs
- Corridor zones
- Inside-core zones
- East/West zones
- South zones

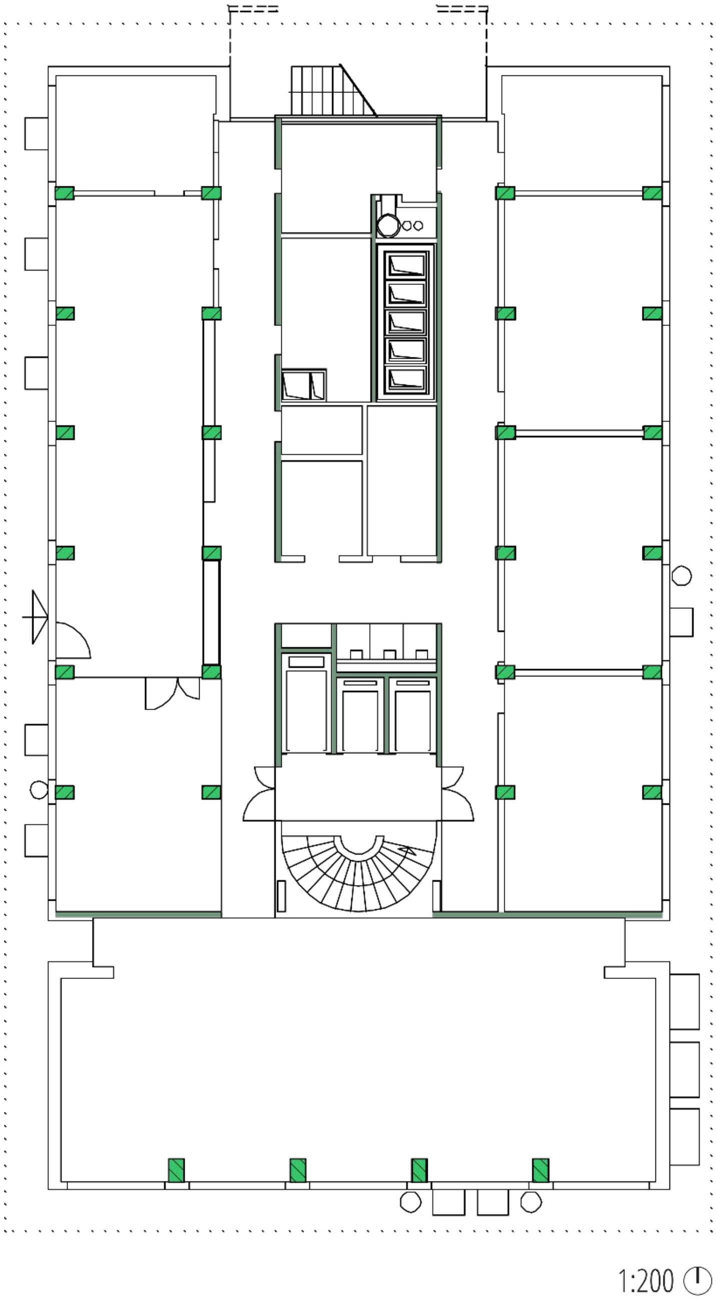
Figure 20. Location of slabs elements (4/4) – Slabs over the 14th floor.



Cast-in-place RC

13 - Interior staircases

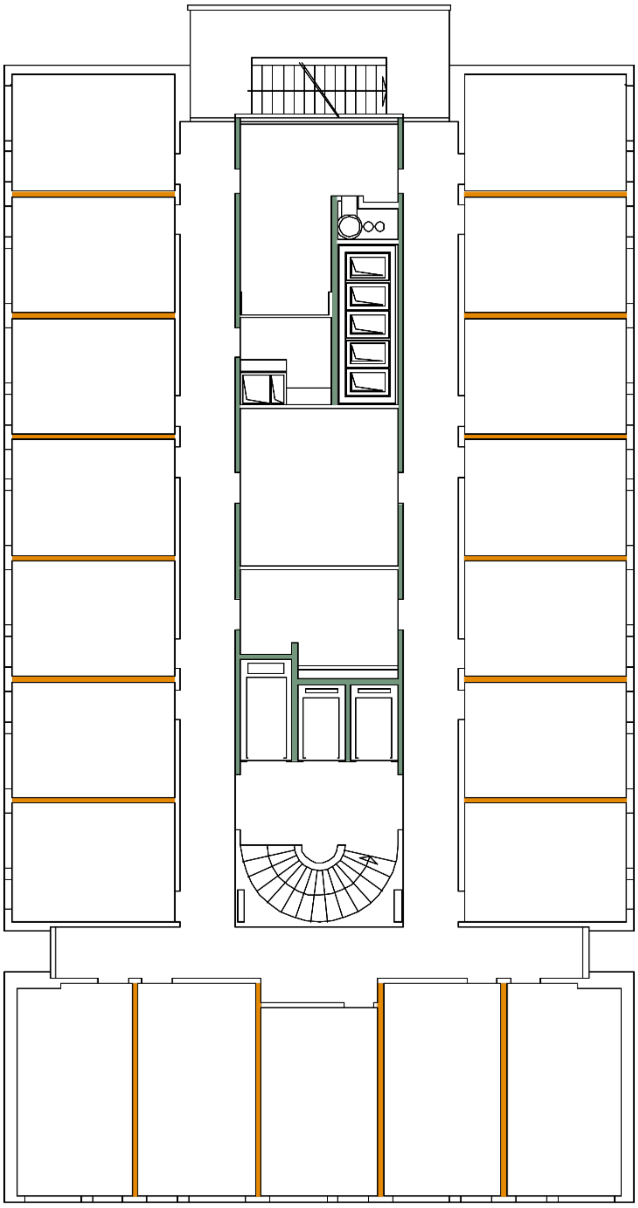
Figure 21. Location of staircases



Cast-in-place RC

- 11 - Cast-in-place interior walls
- 12 - Cast-in-place colums
- East/West zones
- South zones

Figure 22. Location of internal walls and columns (1/2) – Walls and columns of the ground floor



Precast masonry

10 - Preton walls 15 cm

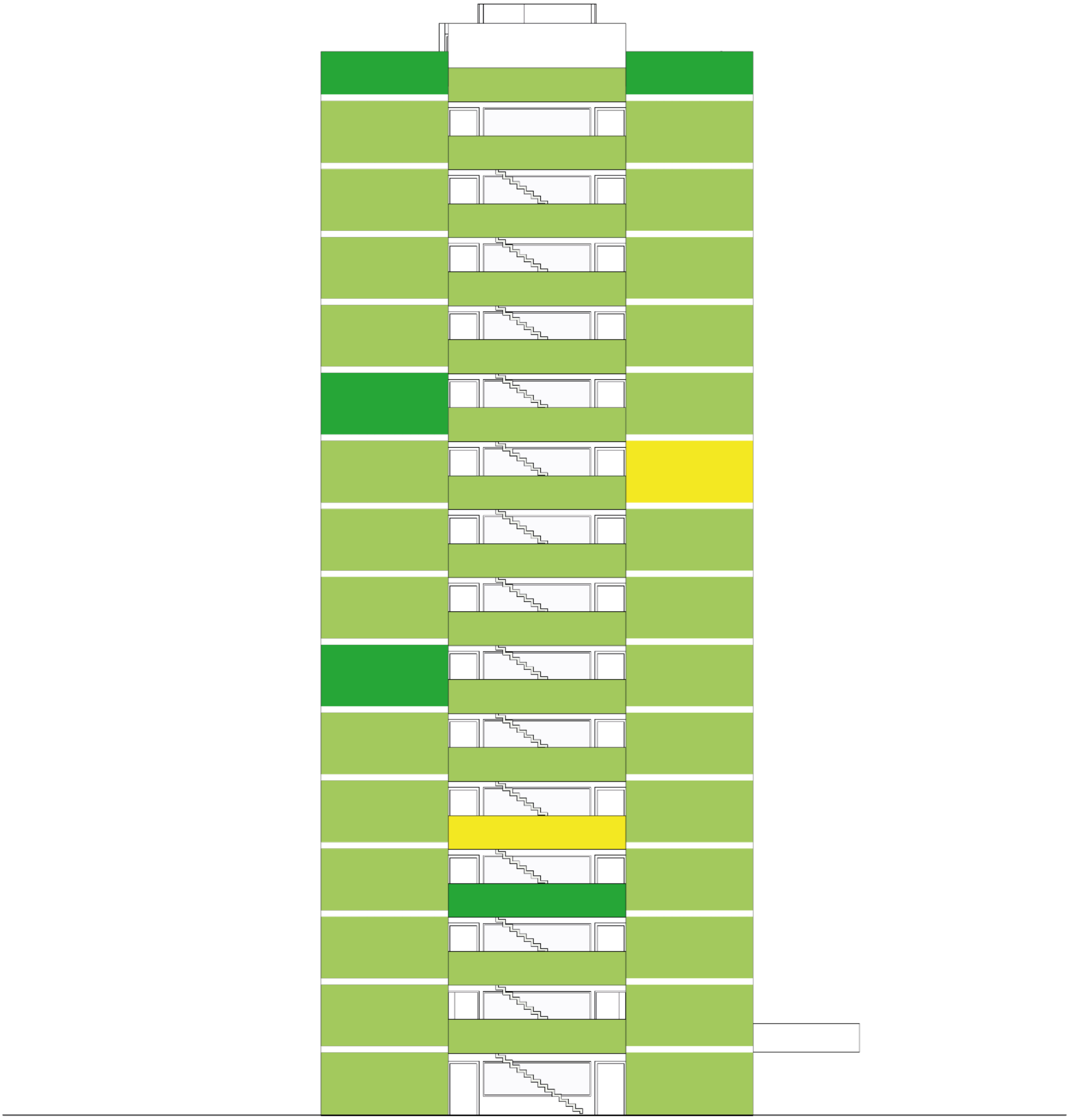
Cast-in-place RC

11 - Cast-in-place interior walls

Figure 23. Location of internal walls and columns (2/2) – Walls of floor 1 to 14

Annex 2 – Facade condition assessment results

Figure 24. East facade condition assessment



Grade of condition assesment

- 1 - Good condition
- 2 - Acceptable condition
- 3 - Deviant condition
- 4 - Bad condition
- 5 - Failure condition

Figure 25. North facade condition assessment

Grade of condition assesment

- 1 - Good condition
- 2 - Acceptable condition
- 3 - Deviant condition
- 4 - Bad condition
- 5 - Failure condition

Figure 26. South facade condition assessment

Grade of condition assesment

- 1 - Good condition
- 2 - Acceptable condition
- 3 - Deviant condition
- 4 - Bad condition
- 5 - Failure condition

Figure 27. West facade condition assessment

Annex 3 – Compressive test results

In the next pages, the test reports prepared by TFB are given.

Technik und Forschung im Betonbau

Eberhard Bau AG
Herr Bruno Umbricht
Hafenstrasse 87
4127 Birsfelden

Projekt-Nr.:	212634-01		
Objekt	**Zürich - Sondagebohrungen Trielmli, Hochhaus Gebäude A**		
Bauteil/Referenz	**Fassadenelement**		
Auswahl	Probenahme durch TFB	Probeneingang	05.11.2021
Bearbeitung	geschnitten		
Oberflächenzustand	geschliffen		
Prüfkörperoberfläche	trocken, wie angeliefert		
Bemerkung			

BK 1 - BK 3

Druckversuch Bohrkern 100x100 **SN EN 12504-1 / SOP 3051**

Herstelldatum: unbekannt Probenalter: unbekannt

Prüfdatum: 08.11.2021 Prüfer: gm

Vorbereitung: Schneiden Feuchtezustand Oberfläche: wie angeliefert Dmax: 32 mm

Name	**Durchmesser [mm]**	**H/D**	**Höhe [mm]**	**Masse [g]**	**Rohdichte [kg/m³]**	**Bruchlast [kN]**	**Festigkeit [MPa]**
KB_FNO	100.3	1.0	98.5	1856.0	2390	407.5	51.6
KB_FSO	100.3	1.0	99.8	1899.0	2410	463.0	58.6
KB_FSW	100.2	1.0	98.6	1864.0	2400	494.2	62.7
Mittelwert					**2400**		**57.6**
Std. Abw.					9.95		5.6

Labor Physik: Yannick Esch

Yannick Esch

Wildegg 17.11.2021

Die Prüfergebnisse haben nur Gültigkeit für die untersuchten Proben. Dieser Bericht darf nicht auszugsweise kopiert werden. Unzerstörte Proben werden nach der Prüfung 2 Monate aufbewahrt. Das Auftragsdossier wird während 13 Jahren archiviert. Der Auftraggeber kann die Dienstleistungen innerhalb von 30 Tagen beanstanden. Bitte beachten Sie die "Allgemeinen Geschäftsbedingungen". Weitere Informationen: www.tfb.ch.

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Technik und Forschung im Betonbau

Eberhard Bau AG
Herr Bruno Umbricht
Hafenstrasse 87
4127 Birsfelden

Projekt-Nr.:	212634-02		
Objekt	**Zürich - Sondagebohrungen Trielmli, Hochhaus Gebäude A**		
Bauteil/Referenz	**Prelam-Decke**		
Auswahl	Probenahme durch TFB	Probeneingang	05.11.2021
Bearbeitung	geschnitten		
Oberflächenzustand	geschliffen		
Prüfkörperoberfläche	trocken, wie angeliefert		
Bemerkung			

BK 1 - BK 4

Druckversuch Bohrkern 100x100 **SN EN 12504-1 / SOP 3051**

Herstelldatum:	unbekannt	Probenalter:	unbekannt
Prüfdatum:	08.11.2021	Prüfer:	gm
Vorbereitung:	Schneiden	Feuchtezustand Oberfläche: wie angeliefert	Dmax: 32 mm

Name	**Durchmesser [mm]**	**H/D**	**Höhe [mm]**	**Masse [g]**	**Rohdichte [kg/m³]**	**Bruchlast [kN]**	**Festigkeit [MPa]**
KB_DNO	100.3	1.0	100.1	1894.0	2390	339.2	42.9
KB_DSW	100.2	1.0	100.2	1896.0	2400	315.4	40.0
KB-DSO	100.1	1.0	100.7	1848.0	2330	169.8	21.6
KBL-DI	100.2	1.0	100.8	1911.0	2400	266.0	33.7
Mittelwert					**2380**		**34.6**
Std. Abw.					33.51		9.5

Labor Physik: Yannick Esch

Yannick Esch

Wildegg 17.11.2021

TFB AG – Lindenstrasse 10 – CH-5103 Wildegg – Tel 062 887 72 72 – Fax 062 887 72 70 – www.tfb.ch

Technik und Forschung im Betonbau

Eberhard Bau AG
Herr Bruno Umbricht
Hafenstrasse 87
4127 Birsfelden

Projekt-Nr.:	212634-03
Objekt	**Zürich - Sondagebohrungen Trielmli, Hochhaus Gebäude A**
Bauteil/Referenz	**Wände**
Auswahl	Probenahme durch TFB — Probeneingang 05.11.2021
Bearbeitung	geschnitten
Oberflächenzustand	geschliffen
Prüfkörperoberfläche	trocken, wie angeliefert
Bemerkung	

BK 1 - BK 3

Druckversuch Bohrkern 100x100 **SN EN 12504-1 / SOP 3051**

Herstelldatum: unbekannt — Probenalter: unbekannt
Prüfdatum: 08.11.2021 — Prüfer: gm
Vorbereitung: Schneiden — Feuchtezustand Oberfläche: wie angeliefert — Dmax: 32 mm

Name	Durchmesser [mm]	H/D	Höhe [mm]	Masse [g]	Rohdichte [kg/m³]	Bruchlast [kN]	Festigkeit [MPa]
KB_OI	100.1	0.9	89.9	1629.0	2300	201.7	25.6
KB_ONO	100.3	1.0	99.8	1933.0	2450	569.5	72.1
KB_ONW	99.9	1.0	100.0	1939.0	2470	555.8	70.9
Mittelwert					**2410**		**56.2**
Std. Abw.					94.45		26.5

Labor Physik: Yannick Esch

Yannick Esch

Wildegg 17.11.2021

SWISS ACCREDITATION sas.admin.ch STS 0133

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Annex 4 – Carbonatation and cover concrete thickness measurements

In the next pages, the measurement reports on the prepared by TFB are given.

Technik und Forschung im Betonbau

Eberhard Bau AG
Herr Bruno Umbricht
Hafenstrasse 87
4127 Birsfelden

Wildegg, 18.11.2021

bruno.umbricht@eberhard.ch

Prüfbericht Nr.:	**212634-05**
Objekt:	Zürich - Sondagebohrungen Triemli, Hochhaus Gebäude A
Bauteil/Referenz:	Karbonatisierungstiefen und Armierungsüberdeckung
Eingang TFB:	01.11.2021
Probenherkunft:	Probenahme durch die TFB
Probenmaterial:	Bohrkerne aus Bauwerken
Prüfdatum:	18.11.2021

Karbonatisierungstiefe von Beton
SN EN 14630:2006 / SOP 3025

TFB-Nr.	Probenbezeichnung	øKarbo-Tiefe, Gebrochen	Max. Karbo-Tiefe, Gebrochen
144652	KB_FNO	16 mm	19 mm
144653	KB_FSO	2 mm	6 mm
144654	KB_FSW	10 mm	19 mm
144655	KB_DNO	<1 mm	<1 mm
144656	KB_DSW	<1 mm	<1 mm
144657	KB-DSO	<1 mm	<1 mm
144658	KBL-DI	<1 mm	<1 mm
144659	KB_OI	12 mm	15 mm
144660	KB_ONO	14 mm	16 mm
144661	KB_ONW	8 mm	20 mm

Bemerkungen:

Art	Bohrkerne
Verwendeter Indikator	Mischindikator
Abmessungen	Ø 50 mm

Chemisches Labor: Doris Baumgartner

TFB AG – Lindenstrasse 10 – CH-5103 Wildegg – Tel 062 887 72 72 – Fax 062 887 72 70 – www.tfb.ch

Technik und Forschung im Betonbau

Eberhard Bau AG
Herr Bruno Umbricht
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Wildegg, 18. November 2021

Armierungsüberdeckung gemessen an Bohrkernen

Objekt **Zürich - Sondagebohrungen Triemli, Hochhaus Gebäude A**
Bauteil **Armierungsüberdeckung**
Projekt-Nr. 212634-05

Eingang Labor 05.11.2021
Entnahme durch TFB AG
geprüft durch sb

Proben-bezeichnung	Seite	Ø [mm]	Überdeckung (Tiefe in KB) [mm]	Seite	Ø [mm] 1. Eisen	Ø [mm] 2. Eisen	Überdeckung (Tiefe in KB) [mm] 1. Eisen	Überdeckung (Tiefe in KB) [mm] 2. Eisen	Bemerkung
KB_ONW	innen	10	28	aussen	10	10	30	40	
KB_ONO	innen	8	30	aussen	10	-	40	-	
KB_FSW	innen	4	28	aussen	4	4	20	23	
KB_FNO	innen	4	45	aussen	4	4	20	23	
KB_FNO (3. Eisen)	-	-	-	aussen	10	-	26	-	
KB_FSO	innen	4	35	aussen	4	4	16	20	
KB_DSO	-	-	-	Deckenun.	6	6	20	25	Deckenuntersicht
KB_DI	-	12	-	-	-	-	-	-	Längseisen
KB_DSW	-	-	-	Deckenun.	6	6	20	25	Deckenuntersicht
KB_DWO	-	-	-	Deckenun.	6	-	25	-	Deckenuntersicht

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