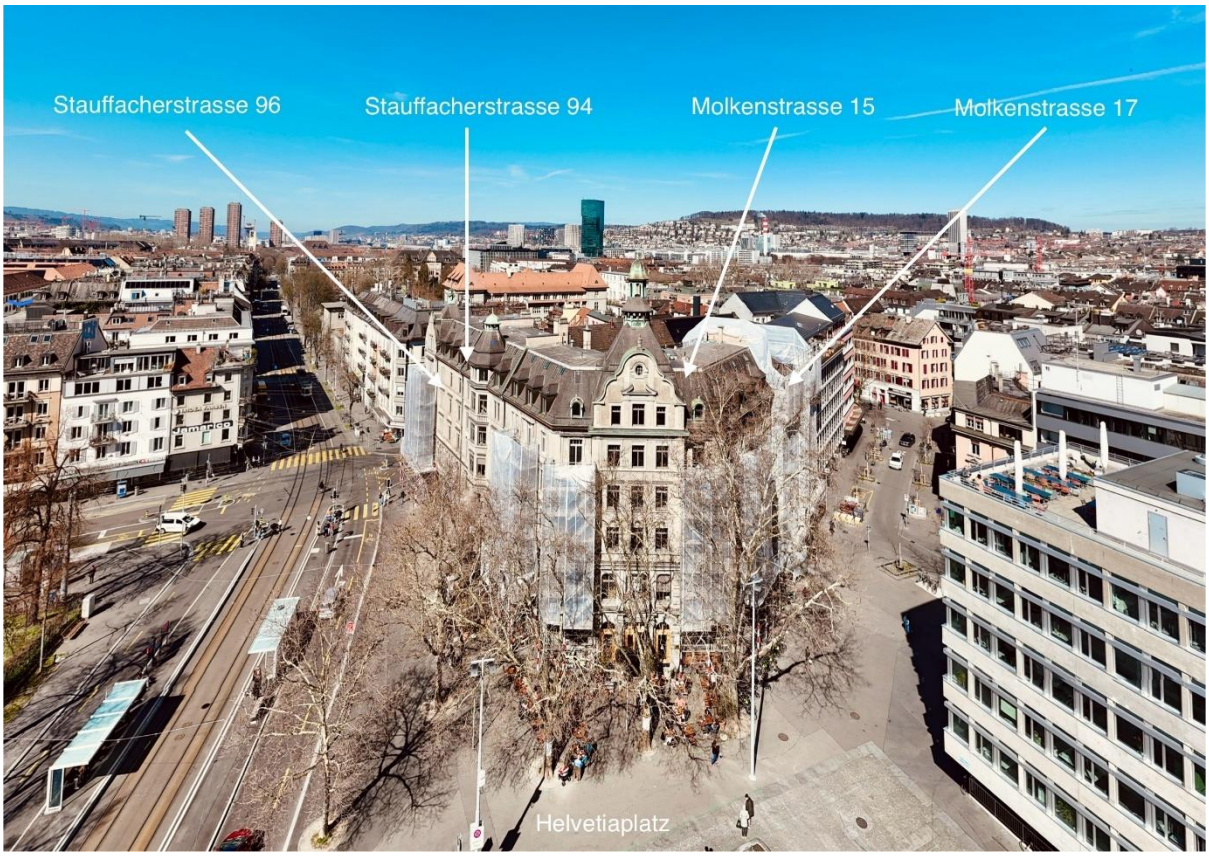
BUCHER BAUINGENIEURE

Conversion, Vertical Extension, Seismic Retrofitting & Refurbishment

Residential and Commercial Buildings at Helvetiaplatz, Zurich

Molkenstrasse 15 & 17, Stauffacherstrasse 94 & 96



Duration
2024 - 2025

Owner
Swiss Life AG, Zürich

Reference Contact Person
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Architect & General Contractor
Bär Baumanagement AG

Services Provided

- Structural Engineering and Planning
  - Seismic Retrofitting
  - Vertical Extension
  - Conversion
  - Renovation
  - Retrofitting of Foundations
  - Floor Plan Optimization
- Construction Supervision

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The construction project at Helvetiaplatz in Zurich (Switzerland) comprises four residential and commercial buildings. Within the project, these are referred to as the "old buildings" (former bank) and the "new buildings". They differ in terms of construction methods, which in turn affect the approaches used for seismic assessment and the necessary strengthening measures:

	«OLD BUILDINGS» STAUFFACHERSTRASSE 94 & 96, MOLKENSTRASSE 15	«NEW BUILDING» MOLKENSTRASSE 17
YEAR BUILT	1905	1954
STOREYS	Basement Ground Floor 1st to 4th Floor 1st and 2nd Top Floor	Basement Ground Floor 1st to 5th Floor 1st Top Floor
WALLS	Masonry	Masonry, Reinforced Concrete
COLUMNS	Steel Columns	Reinforced Concrete Columns
CEILINGS	Hollow-Core Slabs Timber Beam Floors	Reinforced Concrete Slabs
VERTICAL EXTENSION	-	Steel Construction & Timber Construction
SEISMIC ANALYSIS AND DESIGN	Push-Over Analysis (3Muri)	Response Spectrum Analysis (AxisVM)
SEISMIC RETROFITTING	Steel Construction	Steel Construction & Reinforced Concrete
HERITAGE PROTECTED	yes	no

The client pursued several objectives with this construction project. Molkenstrasse 17 was extended by one floor, and the existing structure was renovated at selected locations. Floor plan changes led to extensive remodeling works. Regarding earthquake safety, all four buildings were analyzed and strengthened accordingly.

Ecological and Social Sustainability

Through the renovation of the existing buildings, compared to new construction, both resources and embodied energy were saved, while construction waste and emissions were reduced. Moreover, culturally and architecturally valuable buildings were preserved, which integrate much better into the urban environment than a potential new building would have.

Construction During Ongoing Operations

All tenants – including a restaurant, a bakery, a flower shop, and several offices – were able to continue operations throughout the construction work in the basement and upper floors. Only two ground-floor commercial units had to close temporarily to allow for the installation of steel frames and cross bracing within their premises.

Heritage Protection

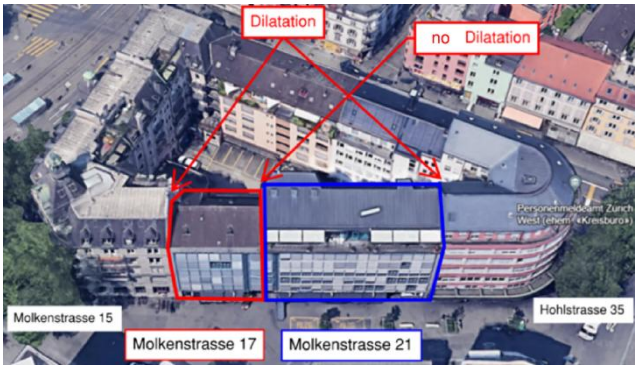
For the buildings at Molkenstrasse 15 and Stauffacherstrasse 94 and 96, built in 1905, special consideration had to be given to heritage protection when selecting and implementing structural measures. Changes to the façades were not permitted, and interior measures had to be coordinated with the heritage preservation authorities.

Earthquake Analysis and Strengthening

Earthquake analysis and strengthening were key components of this project. The existing structure had to be analyzed and, where necessary, brought up to current standards. Since the buildings differ in their construction type, the "old buildings" and the "new building" were analyzed and strengthened using different methods. The goal was to achieve, with proportionate measures and a remaining useful life of 40 years, the fulfillment factor of 0.70 as defined in the SIA standard (Fig. 6, SIA 269/8), corresponding to the current standard for new buildings.

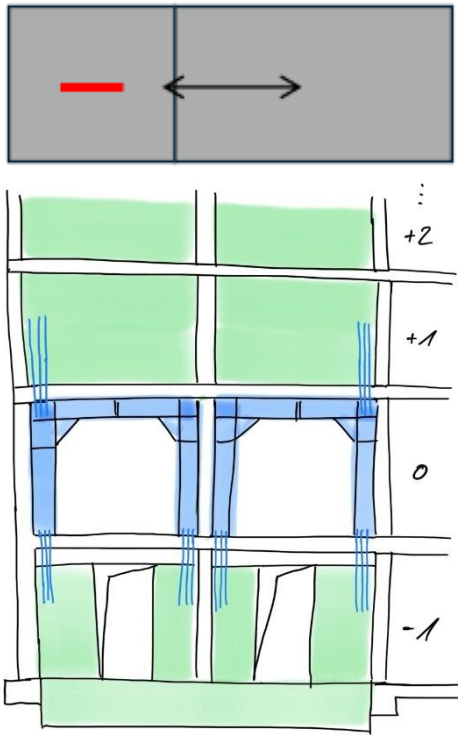
Earthquake Consideration for the "New Building" (Molkenstrasse 17)

The building, which is a combination of reinforced concrete and masonry, was analyzed for earthquake safety using the response spectrum method.



Since the part of the building at Molkenstrasse 17 is not dilated from the adjacent Molkenstrasse 21, the entire building mass was considered in the earthquake analysis. In consultation with the neighboring property owner, it was decided that the measures should be designed so that the earthquake strengthening of Molkenstrasse 21 is achieved with the measures in the Molkenstrasse 17 building. The cost-sharing was determined proportionally based on the building volume. No tenant of the neighboring property was required to move out or lose floor space due to structural measures.

In the **transverse direction**, continuous firewalls were present, so the fulfillment factor was just below the minimum required value of 0.25 % for existing buildings. Carbon fiber reinforcements were used to reinforce the cross walls until the defined target value was met.



Due to the original skeletal construction, there was no existing **longitudinal bracing**, and a new system had to be developed from scratch. The schematic sketch on the right illustrates the structural concept. In the basement, a new massive strip foundation and earthquake walls were constructed, on which the new seismic axis was extended up to the attic. Two rigid steel frames made of HHD 400×287 S355 profiles enabled an open layout on the ground floor without significant loss of usable space for commercial purposes. The connection to the first floor was made using exposed threaded reinforcements (see photos). In the upper floors, the new apartment partition walls were designed as reinforced concrete shear walls.

A foundation system was developed that does not rely on piles. The reinforced concrete walls in the upper floors span across two bays. The tensile forces at the ends of the spans are transferred via threaded reinforcement into the outer columns of the two rigid steel frames. These outer columns are subject to both tension and compression forces during an earthquake, while the central column is loaded in compression only. This structural concept enabled the efficient design of the strip foundation as a two-span beam.

Floor Plan Optimization of the "New Building" (Molkenstrasse 17)

By revising the original preliminary design, the new shear wall could be relocated onto a residential partition wall that was initially intended to be non-load-bearing. This resulted in a total space saving of approximately 13 m^2.

Earthquake Consideration of the "Old Buildings" (Stauffacherstrasse 94 & 96, Molkenstrasse 17)

Residential and commercial buildings at Stauffacherstrasse 94 & 96 and Molkenstrasse 17 were constructed using masonry, steel, and timber. Due to this structural composition, their seismic behavior was analyzed using the push-over method. One of the key measures was to prevent so-called "soft-story" failure, making the bracing of the ground floor a primary focus.

For example, existing steel frames within the buildings were reinforced with new diagonal steel members. This intervention created rigid frame corners capable of effectively absorbing horizontal forces.

Furthermore, the ground floor slabs were structurally connected to the façade columns. In areas where reinforcement was only possible from below, steel angles were bolted to the façade columns and welded to the steel beams of the hollow-core slabs. This measure prevents buckling of the exterior columns or walls and ensures the structural integrity of the slab system.

In areas accessible from above, post-installed rebar was used along the slab edges to provide anchorage. Additionally, the slabs were upgraded into structural diaphragms by forming compression and tension zones in concrete and integrating diagonal tension elements made of steel strips:

Vertical Extension

The additional story at Molkenstrasse 17 was built using lightweight construction. Due to level differences, a raised floor was required in the attic, which was structurally utilized to cantilever the extended section above the existing passageway. As a result, the existing slab over the passageway was not subjected to additional loads, avoiding the need for structural reinforcement and preventing a temporary closure of the inner courtyard.

General Renovation

Various floor plan modifications, involving load-bearing elements, required structural adjustments.

To meet the regulatory requirements, massive concrete columns in the basement of Molkenstrasse 17 were removed, and the loads were transferred to new beams.

Another key aspect was the structural assessment of the numerous new openings and penetrations required for the new building services, which had to be drilled and reinforced. Wherever possible, existing chimneys were repurposed as service risers.

The closure of an old lightwell within the building allowed for the installation of two new restrooms per floor.

Renovation

Various damaged areas were locally repaired.

At Molkenstrasse 17, the underside of the ceiling beneath the passageway showed extensive corrosion damage. This was caused by inadequate waterproofing and a typical insulation material embedded in the formwork, which led to corrosion and water-bearing cracks over the course of 70 years. After sandblasting and applying a corrosion protection coating, the existing ceiling was strengthened from below with shear dowels and a new reinforcement layer.

At Stauffacherstrasse 94, vertical cracks were visible in the stairwell on the top two floors. These were caused by the inclined roof structure, which transferred horizontal forces to the outer edge of the masonry wall. Due to insufficient vertical load on the top two floors, vertical cracks developed. These were repaired using post-installed anchoring with steel laminates.

Construction in the Heart of Zurich

In addition to the structural challenges, the inner-city location posed spatial constraints. Close collaboration and careful coordination with the contractor and site management played a key role in the project's success.