Grand Casino Prilly - structural retrofit and extension

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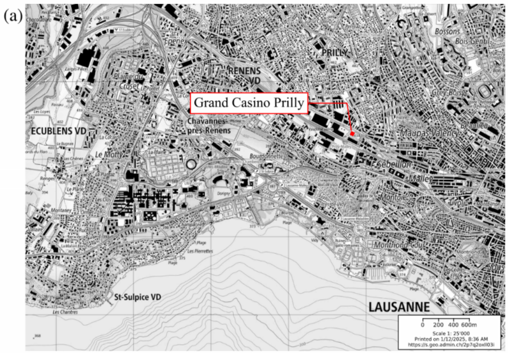
Summary

In the outskirts of Lausanne, Switzerland, a new set of buildings is emerging to make a contemporary neighborhood. Next to several new high-rise buildings, also the transformation of the existing structures is a challenge for designers that limits the environmental footprint of the construction industry. The Grand Casino Prilly is an example of a heavy transformation, where a wide set of architectural and structural requirements are encountered. To find the right balance between costs, architectural design and sustainable construction, the structural engineering uses various solutions to modify, retrofit and add structural elements. Top floors are replaced with mixed timber-concrete slabs and prestressed beams (N05-N03); the lower slabs are strengthened with UHPFRC (N00-N02); and the foundations are retrofitted with micropiles. An excellent example of modern construction that integrates 3D design methods with a creative design procedure in order to find the correct balance between the different requirements.

1 INTRODUCTION

In the western area of Lausanne in Switzerland, a series of larger projects are being build, in order to accommodate the growing population of the agglomeration. Population densification has led to the construction of new infrastructure, such as the new tramway and the development of the Prilly-Malley area with several new residential buildings [1].

In 2022 the federal government of Switzerland decided to give one more license for a commercial Casino to the canton of Vaud. Two main projects were presented to the authorities for this license: Casino Romanel and Grand Casino Prilly. The latter obtained the license from the federal authorities in 2023, and the execution planning started in 2024, see Fig. 01.



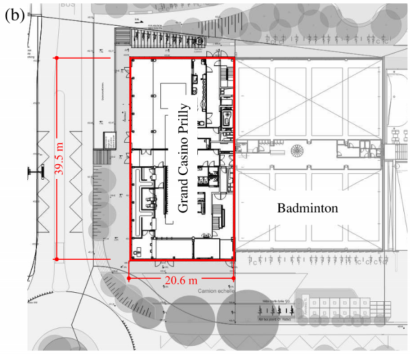


Fig. 1 (a) location of the Grand Casino Prilly; and (b) landscape plan showing major dimensions

The grand Casino Prilly is integrated within the larger project Les Balcons du Viaduc [2]. After the license was obtained from the owner, the existing building (centre-artisanal) was bought from the previous developer, so that the structure could be transformed into a casino.

Locally, the project-area comprises three builds: the new Tilia Tower, the existing Badminton sport center of Prilly and the existing centre artisanal that is to be transformed into the Grand Casino Prilly, see Fig. 2. The entrance to the Badminton sport center is maintained from the existing building. i.e. from the ground floor of the Casino.

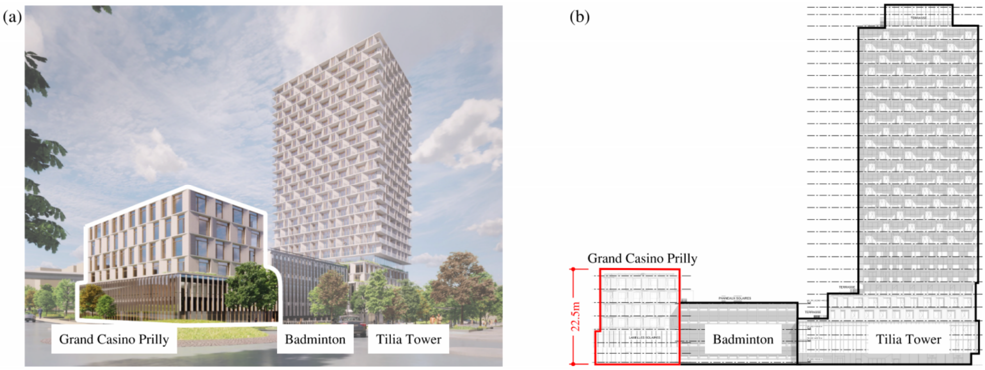


Fig. 2 Les Balcons du Viaduc. (a) view of project area; and (b) south elevation

Both from an architectural as well as from a structural point of view, the transformation of the existing building into a casino presented several challenges: first geometrical, then ecological and economical, but also simplifications for the construction site and assembly sequence significantly influenced the design. Eventually, the most appropriate structural systems and materials are employed to solve different functions – spanning from mixed timber-concrete decks to UHPFRC retrofits and temporary steel-frames for bracing. From this point of view, the project of the Grand Casino Prilly is an optimized compromise of different contrasting requirements.

2 EXISTING STRUCTURE

The two existing buildings, the Badminton sport center and the centre artisanal were built together at the same time in 1989. As shown in Figs. 3 and 4, the Badminton Hall is a fully prefabricated structure with cast-in-situ foundations. The loads from the floors are collected by π-slabs and transferred via prestressed beams to the columns (see Fig. 4).

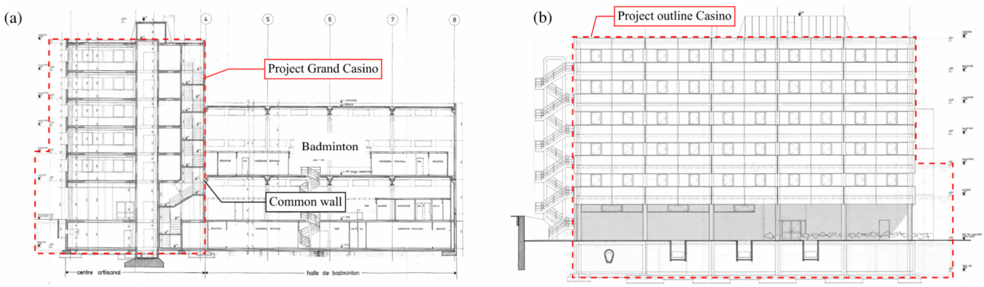


Fig. 3 Existing structures and project outline of the Grand Casino Prilly: (a) section of existing buildings; and (b) elevation of centre artisanal

On the other hand, the centre artisanal was built with an in-situ concrete load bearing structure composed of flat slabs with drop-panels, walls and columns. The building has one underground level and six levels above ground. The Badminton and Casino share the middle wall at the interface between the two buildings. As shown in Fig. 4, a longitudinal corbel takes the vertical loads from the Badminton floors and on the opposite side, the flat slabs of the Casino are monolithic with this middle partition wall. Currently, the horizontal bracing of the Badminton center is assured by the centre artisanal. After the transformation of the Casino, also a structural retrofit is foreseen for the Badminton, which includes an independent bracing system.

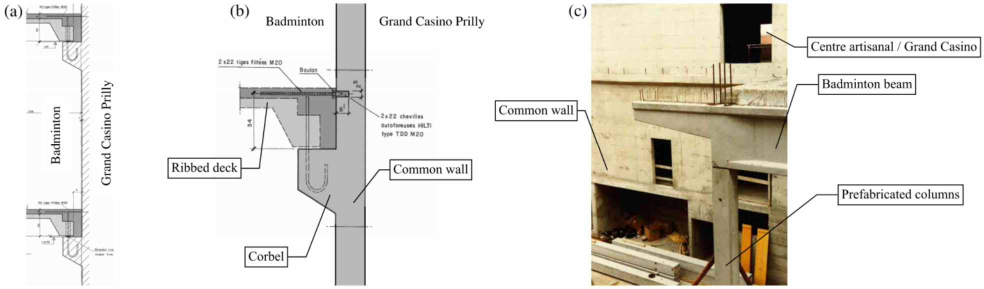


Fig. 4 Existing structures: (a) partition wall between Casino and Badminton; (b) support detail of Badminton deck-slab; and (c) photographic documentation from 1989

For the centre artisanal some old architectural plans were found at the local authorities, but no engineering plans. Due to the absence of information regarding concrete class, steel grade and reinforcement layout, several investigations have been made on the existing structure. It was found that the concrete could be classed as C16/20 and the steel-rebars present a yield point with $f_{yk} > 500$ MPa. In addition, the reinforcement layout was also investigated by ferroscan and destructive methods, so to allow the design of the structural retrofit.

3 GRAND CASINO PRILLY: TRANSFORMATION AND NEW GEOMETRY

The project of the Grand Casino Prilly is based on a previous transformation project of the centre artisanal [2] that was elaborated in 2020. By the time the license for a commercial Casino was obtained by the owner in 2023, a construction permit was already validated for the previous project called Tilia-West. This construction permit was transferred to the Casino, which meant that no changes in the façade layout could be made with respect to the previous project, that a standard of Minergie-Eco is fulfilled, and that the Casino is a transformation of the existing centre artisanal (i.e. not a complete demolition and reconstruction). These strong conditions, in addition to the passage on the ground floor that guarantees the access of the Badminton have strongly impacted the architectural layout.

The planning team of Burckhardt Architects quickly concluded that the existing levels N02-N05 had to be completely demolished and replaced new floors with a different layout. This could accommodate the double height playgrounds with intermediary balconies. On the other hand, the façade columns and slabs over NS1, N00, and N01 are maintained and strengthened.

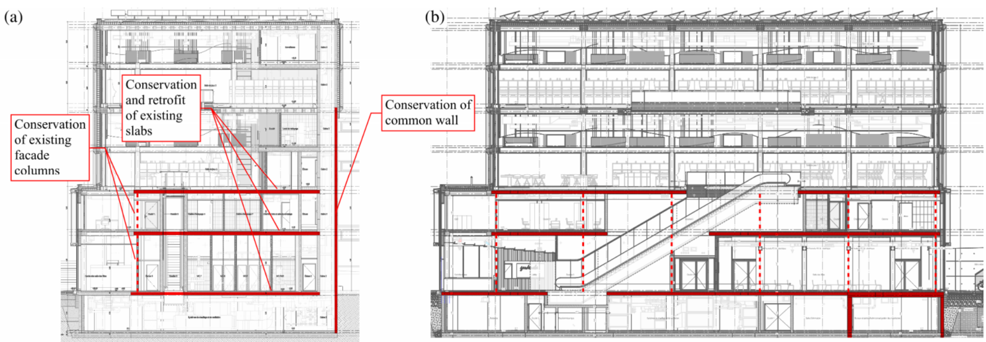


Fig. 5 Project of the Grand Casino Prilly. In red the conserved structural elements: (a) transversal section; and (b) longitudinal section

As shown in Fig. 5, a mechanical escalator allows the access to the playgounds of the Casino, located at level N02. The next playground at level N04 is accesseb by elevators. At the ground floor there is the pathway to the Badminton and a party hall of the Casino, whereas level N01 is reserved for the administration. In order to accommodate all technical installations, the underground had to be extended with respect to its current size, see Fig. 3.

4 VERTICAL LOAD TRANSFER, MATERIALS AND RETROFIT

The overall outline envelope of the Casino is slightly larger with respect to the centre artisanal (see Fig. 3). Thus the load bearing structure can be split into three main parts: (i) the new floors on levels N02 – N05 which are completely rebuilt; (ii) the existing structure on levels NS1 – N01 and; (iii) the extension of the base levels.

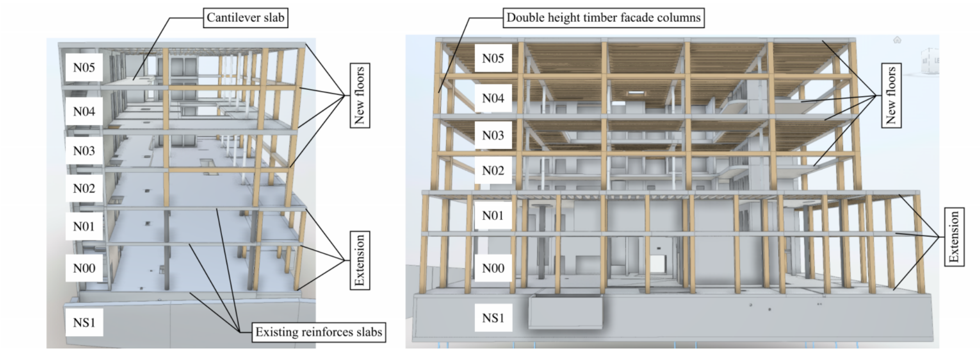


Fig. 6 3D-Model of the project: (a) transversal view; and (b) longitudinal view

For the new floors, the roof deck and slab over N03 are relatively similar. Mixed timber-concrete beams transfer the vertical loads to main prestressed beams. The latter have a size of b × h = 60 × 40 cm with two cables 7T15s prefabricated in C45/55 concrete and a maximum weight of 9.6 to, for a main span of 7.10m. These main beams are supported by double height timber columns (cross-section 440 × 440 mm in GL24h), prefabricated concrete columns (also in double height) and concrete walls, see Fig. 7.

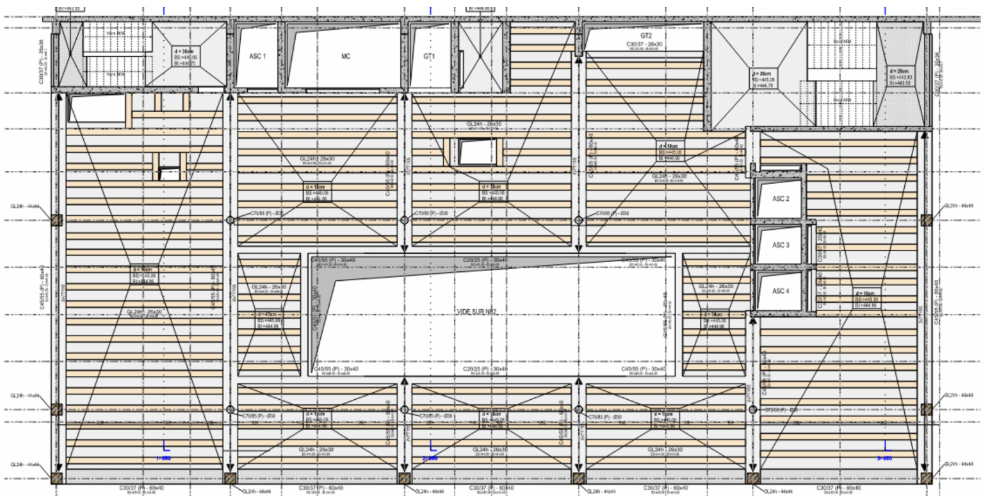


Fig. 7 Load-bearing structure. Slab over N03 (similar to roof slab)

Within the room of double height, there are the slabs over N02 and N04 (Fig. 6a). These are cantilevered from the walls that contain the elevator shafts. Structural serviceability was crucial for the design, which is fulfilled with a 36 cm thick voided concrete slab (with COBIAX elements) and several prestressing cables fixing the slab to the walls of the elevator shaft, see Fig. 8.

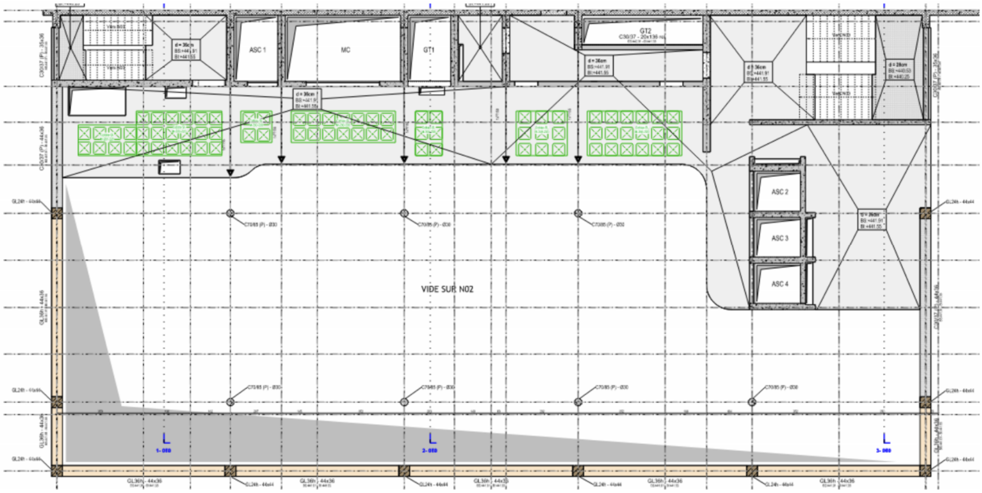


Fig. 8 Load-bearing structure. Slab over N02 (similar to slab over N04)

The lowest three slabs are maintained and strengthened. The existing shafts are closed, and new ones are cut into the existing concrete. All walls are demolished, and new ones are erected to assure the vertical load transfer and horizontal stability. Only the peripheral façade columns are maintained, with an additional post-installed punching reinforcement.

On the east and west-side the building is being extended with a new span of l = 4.00 m. The extension over three floors (NS1, N00, and N01) transfers vertical loads independently with respect to the main building. Horizontal connections to the main structure assure the lateral stability. At levels N00 and N01 the extension is made of mixed timber-concrete decks, prefabricated and in-situ concrete beams with a low amount of prestressing to control deformations and timber columns.

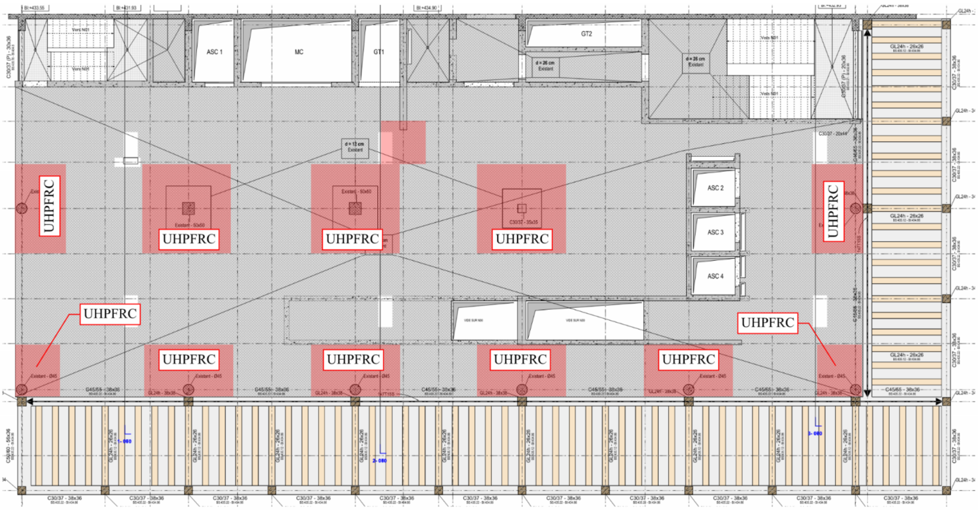


Fig. 8 Load-bearing structure. Slab over N00

4.1 Retrofit of existing slabs

For the structural requirements of the Casino, a retrofit of the existing slabs is compulsory. With respect to the existing structure, the live loads are significantly higher with 5.00 kN/m^2 for the Casino, compared to 2.00 kN/m^2 of the original design [3]. In some areas also safety vaults introduce larger concentrated loads on the existing slabs. Furthermore, a complete change in the layout of walls leads to a different configuration of internal forces within the existing slabs due to the new geometry of supports.

Different structural retrofit solutions have been compared in order to find the most suitable solution: (a) retrofit with 80 mm of Ultra-High-Performance-Fiber-Reinforced-Concrete in the column area (horizontal shear transfer with bond of UHPFRC) and ordinary reinforced concrete outside of the punching area [4]; (b) an additional layer of 80 mm of ordinary reinforced concrete applied the full surface of the slab with a high density of shear connectors within the punching zone; (c) A layer of UHPFRC over the whole slab; and (d) a combination of punching strengthening with a UHPFRC layer and strengthening of the flexural zone with carbon fiber composite sheets.

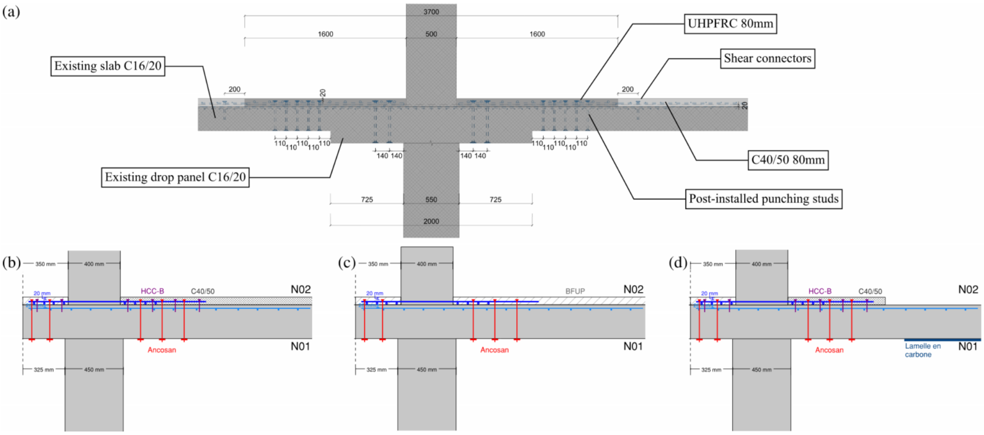


Fig. 8 Retrofitting solutions for existing slabs

In Tab. 1, the different retrofitting solutions are compared. One of the factors influencing the cost of the retrofit is the number of shear connectors that are necessary to assure the collaboration of the two layers. From an economic perspective, variants (a) and (d) are almost identical. Thus solution (a) has been chosen, as is assures a continuity of the top surface of the slabs and the fire protection is already included in the concrete retrofit. As shown in Fig. 8, in addition to the UHPFRC layer in the punching zone, some column-slab connections will also be equipped with post-installed punching studs, in order to assure structural safety [5].

Table 1 Cost comparison of retrofitting solutions

Variant	Connectors [Nr[	Cost for one slab [CHF]	Unit price [CHF/m2]
(a) Mixed: 80 mm UHPFRC + 80 mm C40/50	600 / slab	331’000	555.-
(b) Full surface: 80 mm C40/50	13’150 / slab	397’000	670.-
(c) Full surface UHPFRC	0	401’000	675.-
(d) Mixed: CFC-sheets + 80 mm C40/50	12’550 / slab	329’000	555.-

4.2 Foundations

Generally, it is foreseen to replace the whole foundation slab. Very few walls from the existing structure are being conserved, and the new walls are founded on new foundations. Exception being the foundations under the façade columns, which are being maintained. Detailed static analysis has been performed in order to compare the existing loads with the new ones of the Casino.

For those foundations where an increase in load is calculated, the existing façade foundations are strengthened with a couple of micro piles and a transfer beam. The latter transfers the loads from the existing columns to the piles. The core drills through the existing columns for the placement of the reinforcement shown in Fig. 10 c can only be made after the demolition of the upper levels, once the axial load in the façade columns is reduced to a minimum.

As for the micropiles, those have been installed in an earlier stage, drilling through slab over NS1. They consist of injected ribbed bars diameter D63.5mm with a length of l = 9.00m. The piles are founded in the *molasse* which is the local rock of the region.

Due to the good quality of the soil, also the new foundation slab could be maintained relatively slender, with a thickness of 35.0cm and only few local footings with a height of 60.0cm.

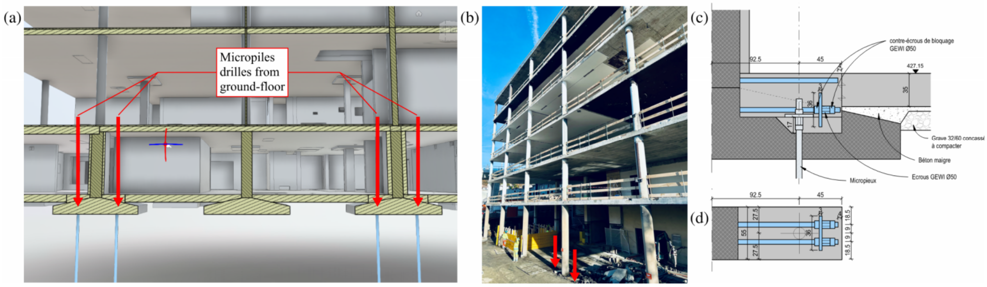


Fig. 10 Strengthening of foundations: (a) section view of building; (b) construction site; (c) section view of reinforcement detail; and (d) plan view of reinforcement

4.3 Construction Phases

In addition to the challenges of the new load bearing structure, comprising a large variety of materials and solutions, the most complex aspect of the project is its construction. The macro-phases are shown in Fig. 11. After the deconstruction of the upper levels, three steel frames need to be erected inside the existing building, in order to stabilize the Casino and the Badminton (see section 2).

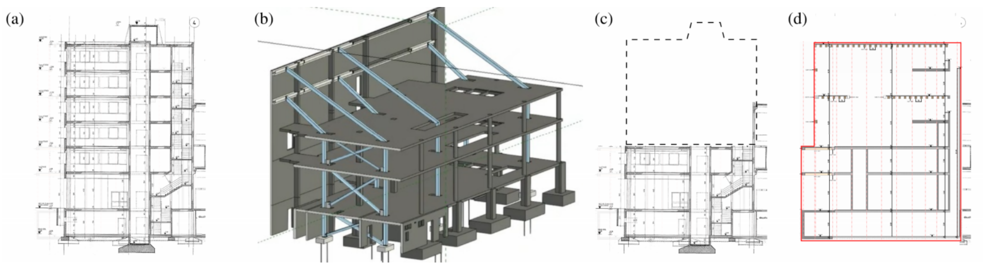


Fig. 11 Construction phases: (a) existing structure; (b) temporary horizontal stabilization of Badminton; (c) completion of demolition; and (d) completion of structural works

In order to limit temporary propping within the ground floors, the construction sequence shown in Fig. 12 has been chosen: (a) current situation; (b) deconstruction of upper floors; (c and j) replacement of existing foundation slab and new foundations – with local underpinning; (d) construction of new walls in the underground; (e) new walls in floors N01 and N02; (f) strengthening of existing slabs; (g) demolition of existing walls; (h) construction of new superstructure; and (i) closing of foundation slab after demolition of walls in the underground.

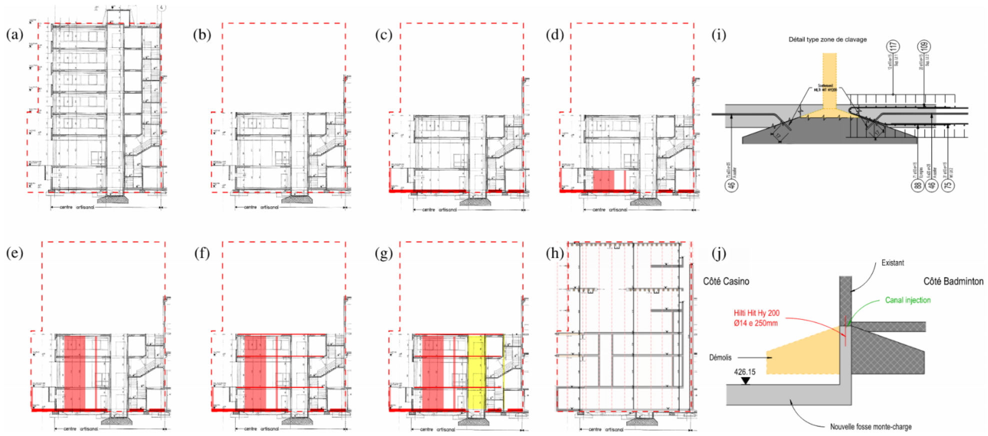


Fig. 12 Construction sequence: (a)–(g) sequence in ground floors; (h) construction of upper floors; (i) reconnection between foundation slabs after wall demolition; and (j) underpinning construction under Badminton middle-wall

5 CONCLUSIONS

The architectural and structural design of the Grand Casdino Prilly has been driven by various stringent boundary conditions. In fact, due to a valid construction permit for a predecessor project, the façade of the Casino must be identical with respect to the previous project. In addition, it had to be a transformation, maintaining at least 30 % of structural elements, to respect the current construction permit. In a collaborative effort, architects and structural designers have worked together to elaborate solutions that satisfy Minergy-Eco ecological standards, find satisfying solutions with a good compromise between costs and construction pace, and respect the construction permit by maintaining a significant portion of the existing structure. As a result, the load-bearing structure of the Grand Casino Prilly is a mix of various solutions, spanning from mixed timber-concrete floors, prestressed concrete beams, UHPFRC retrofit and post-installed punching dowels for strengthening of the existing structure. The conceptual design concerned not only the structure itself, but also the construction sequences. These had to be engineered in every detail, in order assure a sufficiently fast construction pace, reduce costs and assure feasibility. In conclusion this project could set a high standard by bringing together various skills and techniques, ranging from structural modelling, collaborative modelling in 3D but also excellent collaboration between the planning partners.

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