sciendo

INTERNATIONAL CONFERENCE enviBUILD BUILDINGS AND ENVIRONMENT 2019 STU SvF 7th November, Slovak University of Technology, Bratislava

THE MODULAR SWIMMING HALL BUILDING DESIGNS BY F.F. GRÜNBERGER – AN INQUIRY INTO THE BUILDING PERFORMANCE OF VIENNA'S DISTRICT BATHS

Karoline Walal[1], Ulrich Pont[1], and Ardeshir Mahdavi[1]

[1] Department of Building Physics and Building Ecology, TU Wien, Vienna, Austria, Email of corresponding author: ulrich.pont@tuwien.ac.at

ABSTRACT

In the year 1968, the municipality of Vienna, Austria decided on a concept regarding the construction of so-called district baths (public indoor swimming halls). The design of many of the public swimming pools constructed in that period was done by Friedrich Florian Grünberger, an architect, who was considered to be an expert on to swimming hall facilities. His entire oeuvre encompassed swimming pool facilities in many countries of central Europe. Moreover, the majority of his Viennese buildings still exists and is in usage, and form the backbone of the swimming sport facilities in Vienna. This contribution reports on the finding of a recently finished master thesis that focused on the energy performance of swimming halls, in detail of the modular swimming halls designed by Grünberger. Thereby, the original bath designs and retrofit measures that have been applied in recent years were considered. Given the high complexity of swimming pool halls, the energy saving potential of such facilities requires a holistic assessment that includes (i) the building's envelope, (ii) the complex HVAC and operational technology required by the usage, and (iii) the indoor thermal comfort requirements by the customers in the swimming halls. One of the bath halls has been looked upon a bit more in detail (Floridsdorfer Bad). Here, the improvements over time could be studied in detail. The contribution reports onto the current energy usage by the building, contracting models for energy saving, as well as typical policies and potential fallacies of public swimming pool hall retrofit.

INTRODUCTION

In the 1960ies the government of the city of Vienna decided to improve its offer for the Viennese inhabitants regarding indoor swimming pool capacities. After the WWII many of the former sport facilities have been found destroyed or dysfunctional. Moreover, the post-war society demanded a high degree of leisure time and sport facilities. Thus, the city published the *Bezirkshallenbäderprogramm* (district indoor swimming pool program), which did foresee for 333 inhabitants of Vienna 1 m² of indoor swimming pool water surface. Given that Vienna had around 1.5 Million inhabitants at the time, this concept can be considered as ambitious by today. Cost constraints required the swimming pool halls that were intended to be constructed in many Viennese districts to be cost-efficient. The architect who was commissioned as planner was the Austrian architect *Florian Friedrich Grünberger* (1921 – 2007), who was known as domain specialist for social housing and recreational facilities. While Grünberger built the first post-war indoor swimming pool of Vienna (the Floridsdorf indoor swimming pool) even before the *Bezirkshallenbäderprogramm* was published, this and other realizations cumulated in his *Europabadkonzept*, an inexpensive and very versatile designs for medium-size public swimming pool halls. Later realizations in Vienna were based on this *Europebadkonzept*. Figure 1 illustrates a plan of the prototypic Europabad, as published by Grünberger himself [1]. This spatial programme can be considered as versatile and stills form the basis for many

https://doi.org/10.2478/9788395669699-035

swimming pool spatial configurations of today. Grünberger can be considered as widely forgotten, although the majority of swimming pool halls in Vienna are connected with him as planner.

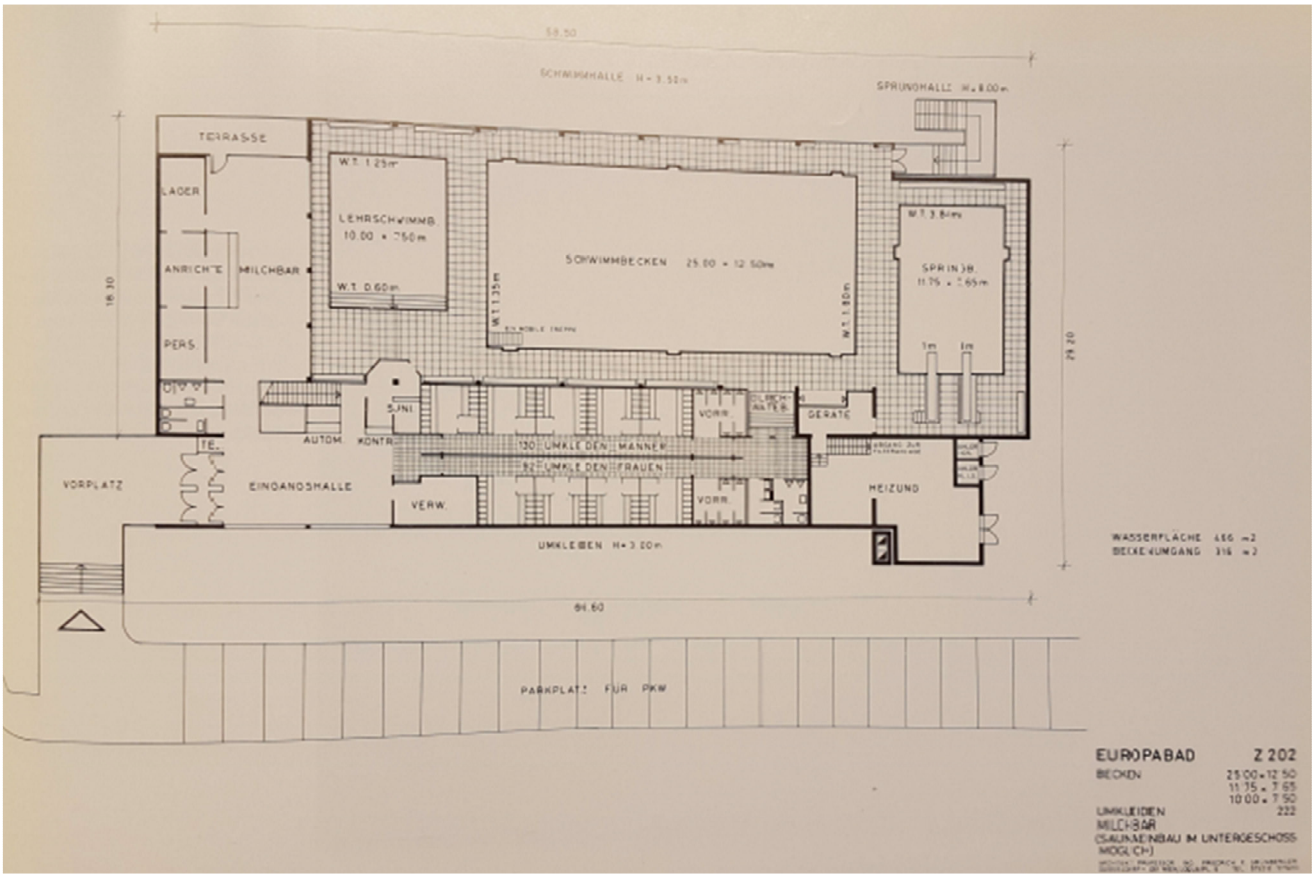

Figure 1. F.F: Grünberger's Europabad plan (based on [1])

VIENNESE BATHING DEVELOPMENT AFTER WORLD WAR II

In post-second-world-war Vienna, 7 of 72 public baths could be found completely destroyed, while 23 were severely damaged. Due to the fact that many residential buildings lacked sanitary basics, the reestablishment of public baths was of high priority for the post-war Viennese government. In 1946, 43 of the urban baths (both swimming pool halls and small *Tröpferlbad* institutions, majorly public showers) were reestablished. The future-oriented bath concepts was published on 2nd of December 1968. This concept stated that within 7 years 14 swimming shall be built, and a budget of half a billion Schilling (around 120 Million Euros as of 2019). The concept was strongly coupled with urban development concepts of the time, and targeted an ideal distribution of swimming pool halls, and a supply of 1 m² of indoor swimming pool water surface per 333 inhabitants. A follow up to the *Bezirksbäderconcept* was the *Bestandsbäderconcept* (redevelopment concept of baths) that was published in 1974, and suggested retrofit measures for existing swimming pool halls, as well as the in-part shut down of shower-only public facilities (which at that time already were widely outdated). To sum up, both concepts suggested the general retrofit of 4 swimming pool halls, and the new construction of large swimming pool halls (e.g. Stadthallenbad bei Roland Rainer) as well as medium-sized swimming pool halls (*Bezirkshallenbäder).* The latter halls were all planned and built by F.F. Grünberger, and included baths in the Viennese district / regions of Hietzing, Döbling, and Simmering (first phase), as well as Donaustadt, Brigittenau, and Großfeldsiedlung (second phase). Additionally, the bath of Ottakring (an already existing building) was supplemented with a Grünberger swimming pool hall. All of the mentioned baths included at 25m by 12.5 m swimming pool, a 12.5 by 8 m teaching pool, a 6 m² children's pool, and the possibility to heat the water in the pools up to 28 to 30 degrees Celsius. Moreover, swimming pools featured amenities such as gender-divided sauna facilities and gastronomy that could be accessed both from the pools and from outside. The swimming pools were opened for public use in 1978 (first phase baths) and between 1982 and 1984 (second phase baths). All of these medium-sized baths are still in use as of today, and form the backbone of the Viennese swimming pool hall supply. However, other baths designed by Grünberger, such as the Dianabad have been put out of Service and being demolished. Needless to say, swimming pool halls in general are buildings of increased energy demand in comparison to other buildings (required high air temperatures, heating up of water, etc.). Furthermore, they require an increased level of maintenance and, after a set of years of operation, intensive retrofit. In between all of the Grünberger baths have been subjected to retrofit.

From a perspective of construction, many of Grünberger's buildings feature reinforced-concrete constructions, roofed by laminated-timber-beam-carried flat roof (Figure 2 shows the swimming pool halls of Hietzing, Döbling, and Ottakring) and extensive natural light distribution by post-and-beam facades and clerestory windows. This construction form allowed for a rather short and inexpensive construction phase and a high degree of prefabrication.

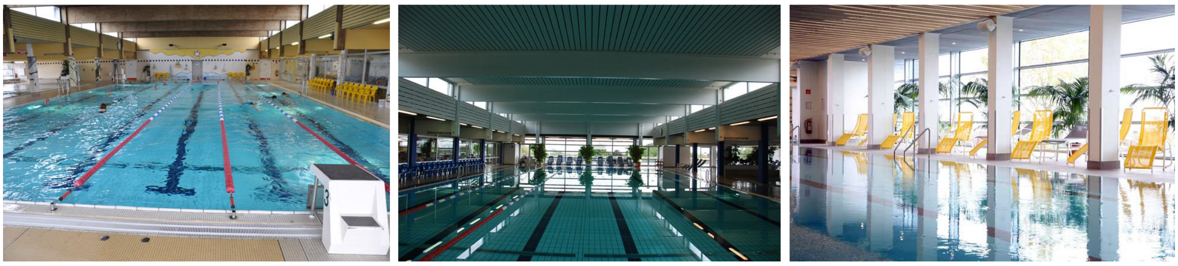

Figure 2. Indoor pools Hietzing, Döbling, Ottakring (all pictures taken from [2])

ASPECTS OF BUILDING PHYSICS IN INDOOR SWIMMING POOL HALLS

Swimming pool halls can be considered to be challenging regarding a number of building physics related aspects:

- The indoor temperature in swimming pool halls has to be maintained on a high level, given the majorly undressed users. Moreover, people leaving the water and having a wet skin will demand high air temperatures to feel an acceptable thermal comfort. Different literature sources [3][4] suggest – to provide thermal comfort – indoor air temperatures between 30 and 34 °C in swimming hall areas, as well as that the room temperatures shall be 2 to 4 K above the pool water temperature (water temperatures are suggested to be between 28 and 32 °C for recreational pools, and a bit lower for athletes).
- Additionally, moisture / relative humidity may be considered as a challenge within swimming pool halls. While the relative humidity in indoor swimming pool halls regularly can be found to be between 40 and 60% it should not be forgotten that these are already large amounts of water that are stored in air at these temperatures. Given that constant evaporation happens above the water body, ventilation is an important aspect. Moreover, the thermal insulation of exterior building components is of highest importance. In the area of lower indoor surface temperatures (e.g. thermal bridges), the high humidity levels might cause condensation and/or mould growth.
- Indoor swimming pool halls not only require a complex HVAC-system (Heating-ventilation-air condition), but also have special requirements for emergency ventilation, given that chlorine is used in the pool halls for reasons of hygienics.
- Appropriate lighting levels are required inside the swimming pool halls, both regarding natural light during day, and artificial lighting during night times. Together with appropriate materials, good lighting conditions reduce the danger of slip-and-slide accidents in the swimming pool halls significantly.

- Swimming pool halls regularly suffer from rather uncomfortable acoustic conditions, given that most construction materials have a hard, water-prood surface, which is in most cases highly noise-reflecting.

THE IMPACT OF RETROFIT: THE CASE STUDY FLORIDSDORFER BAD

The required retrofit after a certain time of usage that is required by sport facilities and indoor swimming pool halls in particular, provides good chances for significant reduction of energy usage and related emissions. Between 2000 and 2017 twelve deprecated public swimming pool halls have been subjected to a thermal retrofit, including most of the Grünberger baths. The operator of the swimming pool halls, the Viennese government agency MA44, received for the retrofit efforts energy-saving awards.
The Floridsdorfer Bad was the first of Grünberger's swimming pool halls in Vienna, and is one of the larger swimming pool halls of his oeuvre. Figure 3 shows the complex (birdsview and indoor view), while Figure 4 illustrates the clever plan-layout of the Floridsdorfer Bad (Ground Floor).

Figure 3. Floridsdorfer Bad (left birdview, right indoor view; all pictures taken from [2])

In the year 2000 the operator of the Viennese Baths, the magistrate department 44, wrote out a public competition for a contracting partner. The contractor thereby was foreseen as to take over the energy management of the buildings to implement energy saving measures. Thereby, the Floridsdorfer Bad received a contractor in 2008 (a company named ENGIE). Retrofit measures conducted since then include the implementation of a roof-mounted solar collector system as supplement for water temperating (1050 m²). Moreover, the ventilation system of the bath was renewed and equipped with a heat exchanging unit. Several small scale interventions pertaining to fire safety, universal design, and all-over user satisfaction have been carried out as well. Additionally, the overall swimming-pool related technology was renewed. These measured resulted in significant savings, which are shown in Table 1.
Interestingly, barely any building envelope related measures have been conducted, such as exchange of windows or addition of any insulation panels to enclosures of the envelope. In qualified interviewers with the contractors it was stated that the contractors do not feel that a building envelope retrofit would provide a fast pay off. Moreover, they stated doubts about the suitability of building retrofit to reach performance goals for swimming pool halls, given the large role the technical systems play in such buildings.
To examine the potential of the thermal envelope retrofit in view of energy savings, a normative calculation for the Heating demand and other KPIs (Key Performance Indicators) was conducted. This was done for the status quo of the building envelope, and then for a set of retrofit measures. For the status quo calculation, the original building constructions from the building plans of the time realization were used as a basis, as well as plans of the extension originating from the 1990ies (Gym / Fitness). U-Values of the windows could be found to be well above today's requirements (which is 1.4 $W.m^{-2}.K^{-1}$ in Austria), ranging from 1.6 to 3.58 $W.m^{-2}.K^{-1}$. In contrast, many of the opaque components features already halfway acceptable U-Values,

which is an indicator that Grünberger was well aware about the necessity of a highly-insulating building envelope. Table 2 illustrates the results of the energy certification of the status quo calculation.

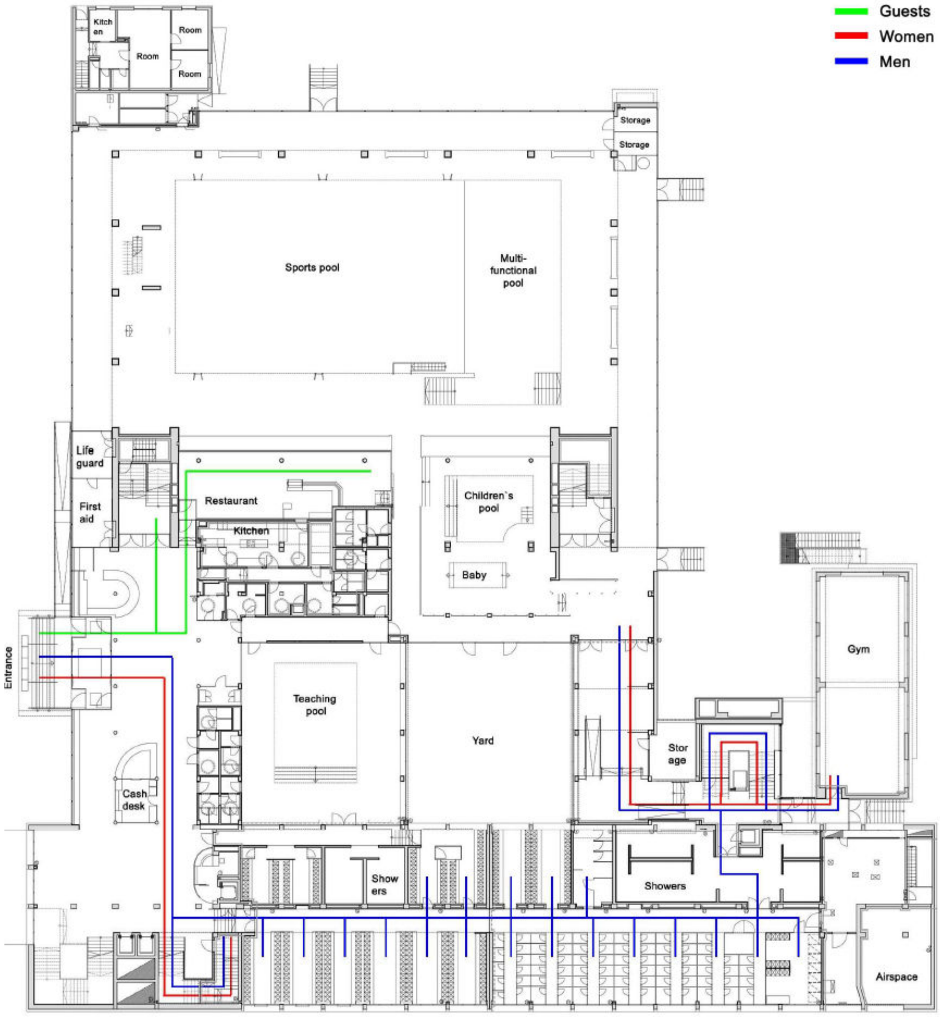

Figure 4. Plan layout of the Floridsdorfer Bad (taken from [5])

Table 1. Energy saving measures'effect in the Floridsdorfer Bad (Comparison between consumption before contracting and in contracting year 8)

Domain	Prior to contracting	Contracting year 8	Unit	Relative change
District heating	6.500	4.267	$MWh.a^{-1}$	-34%
Natural gas consumption	26.200	25.200	$m^3.a^{-1}$	-4%
Electricity	1748	1379	$MWh.a^{-1}$	-21%
Water	130.000	43.390	$m^3.a^{-1}$	-67%

Table 2. Results of the Status Quo Energy Certificate Calculation

Indicator	Value	Unit
Heating demand on location HWB_{SK}	129.01	$kWh.m^{-2}.a^{-1}$
Heating energy demand on location HEB_{SK}	479.33	$kWh.m^{-2}.a^{-1}$
Primary Energy Demand (PEB_{SK})	727.66	$kWh.m^{-2}.a^{-1}$
Carbon Dioxide emissions ($CO2_{SK}$)	137.20	$kg.m^{-2}.a^{-1}$

The heating demand of 129.01 $kWh.m^{-2}.a^{-1}$ does not seem to be a very high value, given the usage of the building. However, the KPIs Heating Energy demand, Primary Energy Demand, and the operation connected CO2-emissions illustrate a rather bad performance of the building.
To assess the improvement potential of the building due to envelope optimizations, two scenarios have been evaluated: Scenario 1 features the change of all transparent components of the building to highly-energy saving windows with an U_{Win}-Value of 1.0 $W.m^{-2}.K^{-1}$. Scenario 2 builds upon Scenario 1 and additionally changes all U-values of opaque components to the minimum requirements of Austria as of 2019. Table 3 illustrates the results of these efforts

Table 2. Results of the Status Quo Energy Certificate Calculation

Indicator	Base Case	Scenario 1	Scenario 2	Unit
HWB_{SK}	129.01 (100%)	120.18 (93.15%)	51.35 (39.80%)	$kWh.m^{-2}.a^{-1}$
HEB_{SK}	479.33 (100%)	462.22 (96.43%)	323.57 (67.50%)	$kWh.m^{-2}.a^{-1}$
PEB_{SK}	727.66 (100%)	707.64 (97.22%)	545.47 (74,96%)	$kWh.m^{-2}.a^{-1}$
$CO2_{SK}$	137.20 (100%)	133.16 (97.06%)	100.44 (73,21%)	$kg.m^{-2}.a^{-1}$

It can be observed that the sole change of windows of these building would not change that much (the KPIs then drop only by 3 to 7%), while a full retrofit of transparent and opaque retrofit results in drops of 25 to 60% of the KPIs. As such, it can be said that an envelope optimization seems only feasible if comprehensively conducted.

CONCLUSION & FUTURE RESEARCH

The present contribution highlighted findings of a recently finished master thesis pertaining to the Viennese swimming pool halls designed by Friedrich Florian Grünberger. Many of these buildings form today's backbone of Vienna's swimming pool infrastructure, and thus their energy demand is of high meaningfulness in view of the role of the public building operators owners of lighthouse projects. While the contracting as integrated in the buildings' operation seem to be feasible, a closer look has to be taken, why and how the buildings' envelopes should be worked upon.

ACKNOWLEDGEMENT

This contribution is based on a recently finished master thesis, written by Karoline Walal [5]

REFERENCES

[1] Grünberger, F.F [ed.] (1974).: F.F: Grünberger 25 Jahre Architekt; in the framework of an exhibition in Künstlerhaus, Vienna, 1974.
[2] City of Vienna: Portal of the Viennese swimming pools: https://www.wien.gv.at/freizeit/baeder/ (last checked: August 2019)
[3] Robatherm [ed.] (n.d.); Raumlufttechnik für Schwimmbäder; Available via https://www.robatherm.com/de/download-broschuren. (last checked: August 2019)
[4] DIN 4108-3 Thermal protection and energy economy in buildings - Part 3: Protection against moisture subject to climate conditions - Requirements, calculation methods and directions for planning and construction
[5] Walal, K: "Architectural & Technical Aspects of Swimming Hall Design by Friedrich Florian Grünberger"; Supervisor: A. Mahdavi, U. Pont; Institut für Architekturwissenschaften, Department of Building Physics and Building Ecology, TU Wien, 2018.

Building Physics and Building Ecology, TU Wien, 2018; final examination: 2018-06-19.