"Zeitbad 21" – Mobile roofs

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All-weather swimming pool with mobile ETFE-air cushion roofs

Introduction

The all-weather swimming pools should be usable and cosy regardless of weather conditions – and during good weather it should be transformed into an open air bath quickly and during bad weather it should be transformed into an indoor bath just as quick.

Even with closed hall the bathers should feel the stimulative solar radiation on their skin. Therefor the cover has to be transparent, translucent, and permeable for UV-A and UV-B radiation. Especially because of the cosiness but also because of the energy costs and the fulfilling of the energy-saving standard the hall will be heat insulated and has warm surfaces.
The life of the all-weather swimming pool is 25 years, so the technical equiment for the drive and the control has to be functional and as simple as possible.

On the example of the „Zeitbäder" Neuss, Emden und Senden the development of our all-weather swimming pools are shown. The focus of the report is on the subjects wheel block, drive, drainage, pneumatic sealing, mobile power supply, synchronised drive control, the influence of wind and snow, accerlating and braking loads, breakdown szenarios as well as the cover with heat insulated ETFE-cushions.

1 Historical owerview

Europe was the precursor for convertible roof structures with the Magrodome type and the Tournesol set.

1.1 Magrodome und Tournesol, source Gerd Schmid [3]

Since 1991 Mitsubishi Heavy Industries [2] in Japan advanced this type of building and instead of GFK or trapezoïdal sheet metal, huge steel structures were covered with two layers of membrane.

2 "Zeitbad 21"

In cooperation with the specialist for baths, the architect Dr. Krieger from Velbert, we have developed roof modules for the "Zeitbad 21"-bath systems which can be opened. After one year of preparation three roofs in different sizes have been designed and are under construction.

2.1 First ideas

In the past we gained experience from the beautiful but sensitive retractable membrane roofs in Regenburg, Bad Hersfeld, Düsseldorf-Flingern and Tecklenburg.

2.1.1 Flingern, source archive formTL

Heat insulated membranes tend to stiffen, therefor they can not be reefed in a single point. As a start we have analysed two prinziples: mobile frames with heat-insulated cushion in between, which can be reefed parallel and mobile supporting grid with multi layer ETFE-cushion cover, which is moved in one piece. We decided in favour of the mobile supporting grid, which showed out to be more functional and adaptable.

2.1.2 Mobile steel-membrane structure, source Sven Haag [1]

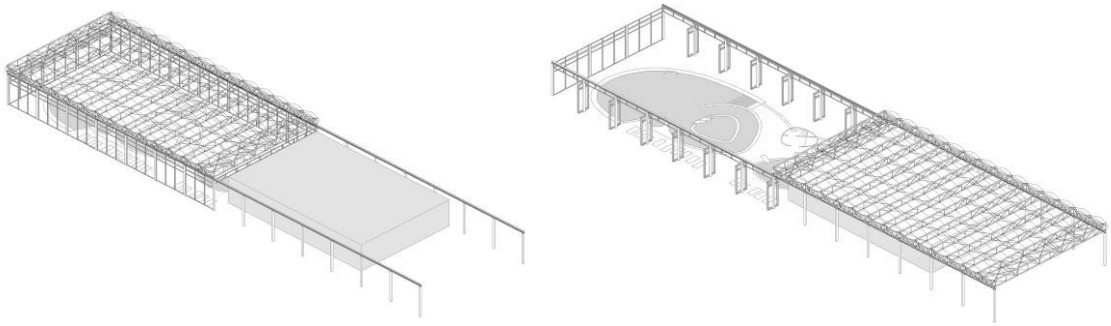
2.2 Concept

The „Zeitbad 21" consists of several bath modules, for instance a sauna module, a changing room module, a restaurant module etc. and a central swimming hall with a roof and façades which can be opened. The advantages of the modules is the compatibility of all modules and the possibility to

calculate the firm building costs in a very short time. Nowadays there are many ramshackle indoor swimming pools and open air baths, so the „Zeitbad 21“ concept offers the town councils the possiblity to make one bath out of two with the qualities of both. This has also a positive impact on a towns finances.

2.3 Way of motion

The most simple way to move something is a straight-line adjustment. We therefor have selected this principle. In open status the roof ist parked above the the adjoining buildings and areas.



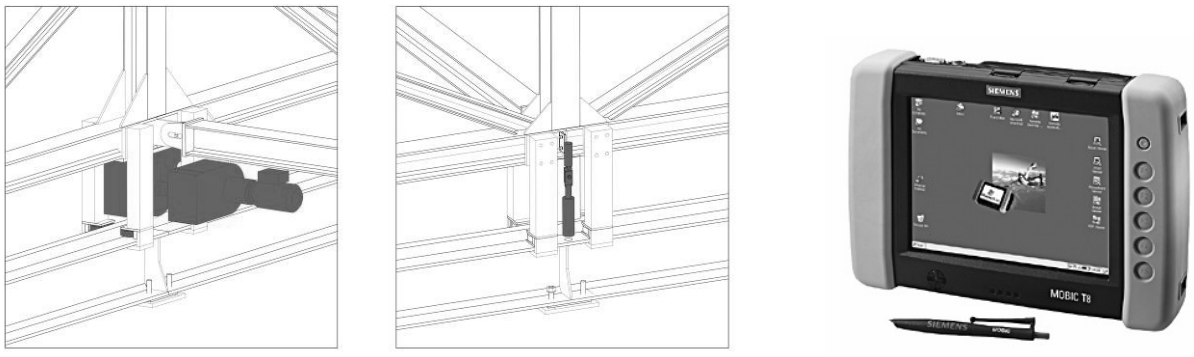
2.3.1 “Zeitbad” in Neuss, left: in Winter, right: in Summer

2.4 Travel wheel system, drive

The mobile roof is seated on eight wheel blocks with a roll diameter of 315 mm of which four are driven. The drives have integrated disc brakes and fix the roof in this parking position.

2.5 Synchronised drive control and operation

Absolute value transmitter are installed on both sides of the roof which are independant of the drives and which take over the fine-tuning of the four drive wheels, so the roof does not cant. The opening and closing is initiated with a mobile remote control by the bath attendant.

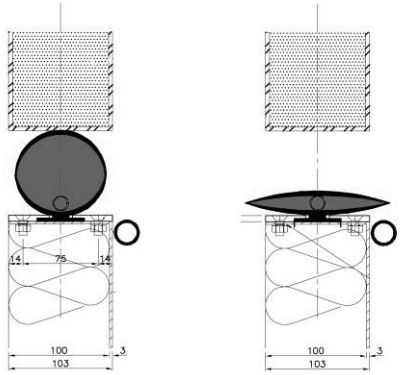


2.4.1 left: wheel block with drive, formTL;
2.9.1 middle:horizontal guide rollers and storm safety device of formTL
2.5.1 right: mobile remote control

2.6 Pneumatic sealing

The horizonal joint between mobile roof and swimming hall façade has to be air tight and rain save – and should not break down during the driving. The rubber lips known from the baths done by DSD in

the 70ths were damaged during the driving and were not totally tight. Thus we used pneumatic sealings from the reactor construction which rise by vacuum if necessary and therefor do not grind on the trails during the driving. During extrem wheather conditions they even can be inflated by overpressure. The about 10 cm sized profiles bypass up to 40 mm joint movement.



2.6.1 pneumatic sealing by formTL

2.7.1 Supplier picture cable track

2.7 Moveable power supply

The drives, sensors and air cushions need moveable power and control cables. Shortlisted are trailing cables and cable tracks.

2.8 Influence of wind and snow, starting and braking loads

For the dimensioning of the structure wind and snow forces are decisive, for the travel wheel system the driving velocity and the weight of the roof. For the crane runway not the starting and braking loads are decisive but the weight of the roof.

2.9 Breakdown scenarios

It is imaginable that a strom is coming up and the roofs does not close. In this case the roof can be moved with a manual winch. In the worst case, claw devices at all wheels avoid, that the roof takes off the rails. Hydraulic storm security devices prevent that the roof moves uncontrolled during strong winds.

2.10 Drainage

The rain water is conducted to the border of the roof and is drained at several points to the lower roof parts. In parking position the down pipe and the rain water funnel stand vis-à-vis.

3 Covers with ETFE-cushions

In direct comparison ETFE is superior to overhead glazing (span, weight, costs, security, cleanness, permeability of radiation), that is why we are equipping roofs of baths and greenhouses with ETFE cushions.

3.1 Large-format ETFE-cushion to look through, source Cenotec

3.2 *Large-format ETFE-cushion Tropical Islands, source formTL*

Because of the missing reinforcement of the extruder foils the span of the pure foils is limited to a few meters, but by means of supporting cable 5000 m² façades like Tropical Islands can be formed.

4 Building physics of the 3-layer large-format ETFE-cushion

The building physicians Dr.Mahler/IB Buchner calculated a seasonable variable U-value between 0,88 and 1,41 W/m²K. They used a ‚hygrothermical analysis' [3] with Meteonorm-weather data for the location Bingen-Ingelheim. The simulations for the heat insulation and for the vapour diffusion give also the requirements for the air guidance within the cushion: the conditioned supporting air is blown into the upper cushion chamber and is blown out at the lowest point of the inner foil. From the inner room, air jets will dry condensate of the room side cushion foil for reason of precaution.

5 References

[1] Haag, Sven 2000, *Entwurfsstudie für eine wandelbare Stahl-Membrankonstruktion zur Überdachung eines Schwimmbades*, Diplomarbeit Hochschule Anhalt/IPL
[2] Ishii,Kazuo1999, *Membrane Design and Structures in the World*, ISBN4-7869-0146-6
[3] Mahler, Dr./IB Buchner 2005: Regionalbad Bingen-Ingelheim, *Hydgrothermische Analyse der Folien-Dachkonstruktion*
[4] Schmid, Gerd 1987: *Wandelbare Hallen - Struktur-und Schwachstellenanalyse,* Schriftenreihe Baukonstruktion Heft 21, Uni Stuttgart