ODOO
PROJECT

ENGINEERING AND CONSTRUCTION BRIEF REPORT

Budapest University of
Technology and Economics

Decathletes

Áts Árpád
Dudás Péter

MŰEGYETEM 1782

sd europe
SOLAR DECATHLON

The Hungarian building industry has been suffering from recession since 2006. This reduces the turnover of the companies producing and taking in the sector. When the structures were chosen, besides the domestic economic situation, we had to adjust to the complex technical requirements we have set for ourselves as well. During the designing process besides forming the architectural character, the mass of the building and the mechanical systems we tried to create an operable, realizable, logical and coherent structural system which can satisfy the special requirements of prefabrication, transportation and lifting.

STRUCTURAL CONCEPTS

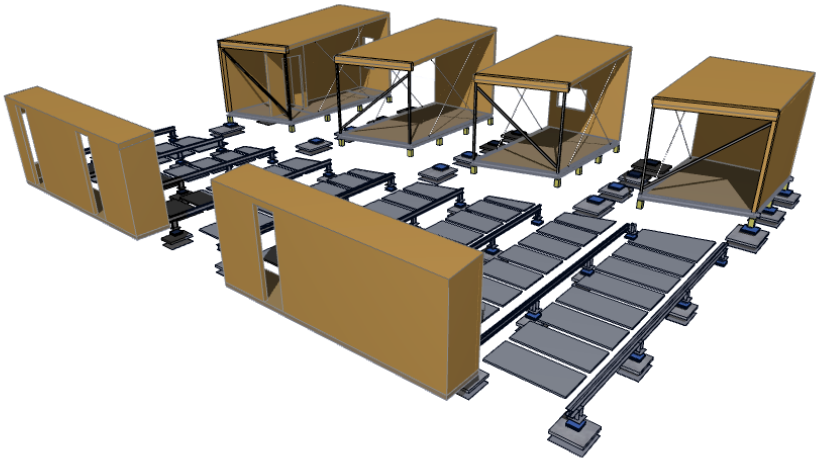
The main mass of the building was designed as **four separated 'box' modules** for transporting purposes. Each module can be precisely implemented previously. This system reduces the possibility of failures can be caused by the very tight scheduled of on construction site operation time and more time can be used for placing the claddings and for adjusting the operation of the house.

Timber was chosen as the main material of the house because it is a environmental building material, its mechanical properties are advantageous, it is light, it improves the insulation capacity of the structure and fits into the architectural concept. The walls and the floors of the building are made of glued-laminated timber panels. Between the panels and between the four modules **custom-designed steel 'ring' connections** can be found. The connection consists of two steel rings sunk into the timber panels and through the bore-holes on the rings a screw-bolt connects them. The connection is rigid, fire-safe and **can be assembled any number of times**. Even in case of big loads it does not impair the timber. At the southern façade with big surface openings steel hollow columns can be found.

For moving the modules a custom-designed **truss-like steel lifting frame** was designed. When the modules are placed next to each other, custom-made positive couplings are used, which force the modules to the correct position.

The timber floors are stiffened with a steel frame because the modules are grabbed at the floor during lifting. The custom-designed **releasable lifting points** are on the steel frame. They can fit in the very low thickness of the floor and their load-bearing capacity is multiple of the similar lifting points used in the industry. During lifting and transportation the modules are stiffened with removable diagonal steel bars. When the modules are connected and the stiffeners are removed the walls and the floors are responsible for the stiffness of the building.

Levelled steel beams support the terrace and the glued-laminated timber summer wall. On top of the steel beams steel tread-grid



Axonometric figure of the supporting structure

supports the adjustable spacers of the terrace cladding. Between the house and the summer wall, over the terrace a **sunsail is stretched**. The hitch on top of the summer wall creates a considerable bending moment at the bottom of the wall. The moment is transferred to the steel beams with a custom-designed **simple heavy-duty connection**.

CONSTRUCTIONAL CONCEPTS

During the design of the structure of the building the aim was to develop a thick, good thermal insulating coating. The thermal insulation is **cellulose** which is made of recycled paper cut and grinded in to small pieces. The manufacturing of this product is going to start in the immediate future in Hungary. On the glued-laminated timber panels from outside wooden framework is fastened which supports the OSB outer cover. The cellulose is compressed in the space between the OSB and the timber panels with blown-in technology. Concerning the windows we tried to choose the **best heat insulation and airtight** product. The supports of the modules of the building are **high-strength Purenit** blocks made of recycled PUR foam. The good insulation Purenit blocks placed into the heat insulating layer reduce the heat bridge cause by traditional transfer structures.

The good insulation Purenit blocks placed into the heat insulating layer reduce the heat bridge cause by traditional transfer structures

The air streaming in the space behind the facade cladding cools down the warmed up facade so reduces the warm up of the interior of the house. The façade is made of glued-laminated timber boards painted black. On the summer wall and on the roof of the building the streaming air behind the solar panels **cools down the solar panels and increases their performance**.

The black solar panels are placed on the low pitched roof with narrow gaps. Under the panels **PVC waterproof membrane** are laid. The fixing of the solar panels is made by a special parallel rail system developed for the PVC insulation. With this system the **stabbing and damaging of the insulation can be avoided**.

There is dropped ceiling everywhere in the living space. **A unique, transportable dropped ceiling system** was invented by us which is integrated with cooling-heating piping system, ventilation and lighting in the interest of standard appearance.

In the bathroom and the living area there are ceramic tiles. Because of the ceramic tiles the floor structure possesses a great thermal conductivity value thus letting an efficient operation of the heating and cooling system. The floor slab is made of a special high-strength screed which bears the transportation and the lifting without any damage.

PLUMBING SYSTEM CONCEPTS

There are four tanks for the water supply of the house to which four water circle join. The second biggest is the **waste water tank** which gathers the house's waste water through the duct system. The domestic **cold water tank** contains drinkable water which provides water for the shower, the sink and the washing machine. **The rainwater gathers into another tank** thus this water can be utilized extensively such as the domestic water consumption can be reduced. We use this water for washing, toilet flushing, cleaning and watering the flowers and plants. The house's passive cooling system is also based on rainwater and to this a **puffer tank** belongs to. At night this water sprinkle the photovoltaic on the roof for the sake of cooling down the water and during the day we use this for cooling and temperating the house.

THERMAL SYSTEM CONCEPTS

In our case, taking the geometry into consideration, to establish the thermal heat collectors fit into the cladding would have had too long payback time because of the low exploitation and **there is a need for heat pump either way**. We decided that thermal heat collectors are not necessary and the supply of the domestic hot water will be made by the heat pump entirely.

PHOTOVOLTAIC SYSTEM CONCEPTS

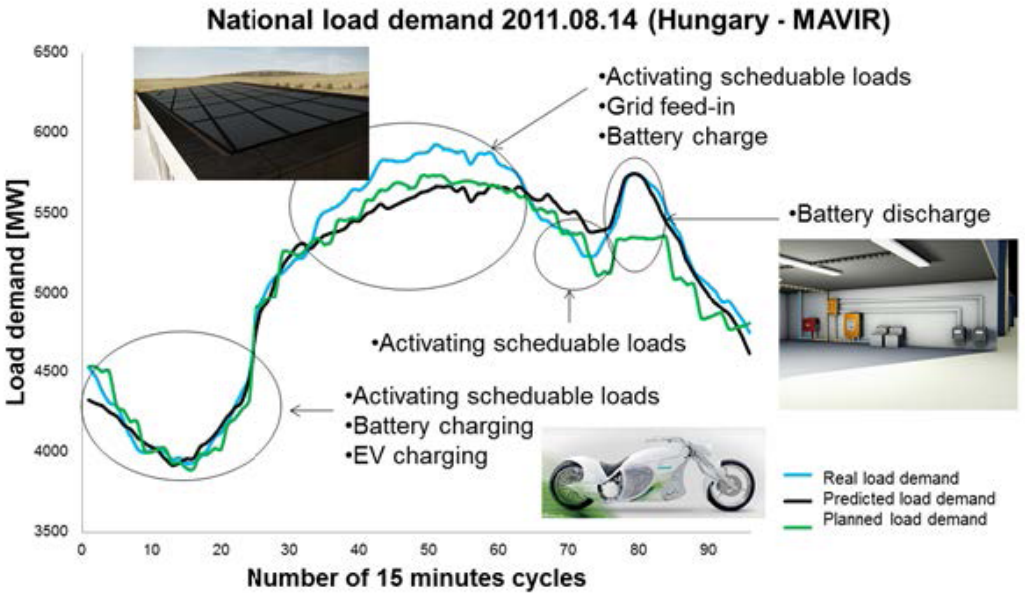
The building's energy maintenance – aside from the low tension distributive network – is supplied with three separate photovoltaic system.

On the roof there are monocrystalline PV modules that are cabled to two inverters with a nominal output power of 3,0 kW while on the summer wall there are thin-film PV modules that are cabled to one inverter with a nominal output power of 2,0 kW and these are attached to the low voltage distribution network.

The MPP control of the inverters are able to **regulate the optimal working point even in partial overshadow** thus it can't happen that certain systems' optimal working points stay on a local extreme not reaching the maximal efficiency. At often overshadow there is a huge significance at the adjustment of these kinds of working points.

At the selection of the inverters an important criteria was **the smooth working in high temperature** because their place were only possible in the middle section of the summer wall and in the case of the systems on the roof the inverters are overloaded on the DC side.

Because of the DC side overload and the modules' dark colour – hereby warmer operating temperature – the **inverters' possible critical operating conditions were tested by a special development, they were analysed with a simulation made in Matlab environment**. According to the results breakdown from thermic overloading of the inverters is not expected and the DC side voltage of each strings stay under the inverters' MPP voltage range even with high cell temperature. The simulation is appropriate **for comparing the most various PV systems**.



In case of emergency additional relays connected to the DC side of the inverter switch off. **A relevant drop in the line voltage operates the miniature circuit breaker in the mechanical room** as well as switching off the DC cables lying under the terrace.

ELECTRICAL SYSTEM CONCEPTS

The electrical consumer circuits' and photovoltaic systems' **energy consumption / prodution is measured by separete electrical meters**. The measurement devies communicate to the belonging KNX gateway through an optical interface so the data can be displayed by the touch panel in the building. In the course of the building's post-utilization, **for the researches related to smart metering**, the complex building engineering control algorythms' further optimization and the active electrical energy storage (accumulators, electrical car), the system is the providing of foundation of the necessary data.

The building's automatisation is based on a KNX system. The communication through this system makes Synco and Logo! possible to control the complex mechanical system, the lighting system through KNX/DALI gateway, visualise consumption data or even the operation of overvoltage protections displaying to the user.

Due to the dilatations needed for the building's transportation, circuits not exceeding 16 A we used standard connectors in favour of easier site installation. During the shaping of heavy power current tracks we put great emphasis on **not only the wires and cables to be halogen free** but if possible the flexible protective conductors, junction boxes and cable glands.