INTRODUCTION OF LÖGLEN TECHNOLOGY

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DESCRIPTION OF LÖGLEN TECHNOLOGY

Löglen technology provides a construction system which combines steel or lumber load-bearing frame structures and polystyrene concrete components. This way, they become suitable for constructing buildings. Below, the characteristics of the technology are described.

RAW MATERIALS

Löglen structures basically consist of two or three main raw materials, depending on whether the roof and wall structures are made of different materials or the same. The raw material used for wood and steel profiles is easy to procure in mostly any country, for nearly the same, global prices (the parity of transportation may cause differences). Furthermore, the two materials are completely substitutable by one another.

In Hungary, mostly steel is used for the frame structure, and lumber is used for the roof structure. On demand, the entire structure (walls and roof) can be made from lumber or steel uniformly.

We display through the Hungarian example how the parts of the frame structure are made.

The profiles made from hot-dip galvanized steel are put together with screws during preassembly and on-site construction.

In the production of the roof structure the lumber profiles are cut to size, and then put together on a special workbench with nail plates.

Polystyrene granule is prepared by polymerizing styrene beads. Bead polymerization provides an opportunity to mix materials with low boiling point into the system. The polystyrene granule is a conglomeration of beads with diameters of 0.1-0.3 mm, the density of the beads is about 1000 kg/m^3. In the first stage of the expansion, the beads are heated to a temperature below 100°C, and then the propellants they contain vaporize, and they inflate the thermoplastic material to a diameter of 1-5 mm. This way, we obtain a loose conglomerate that is mixed with cement after cooling down and then it is poured and compacted into a formwork.

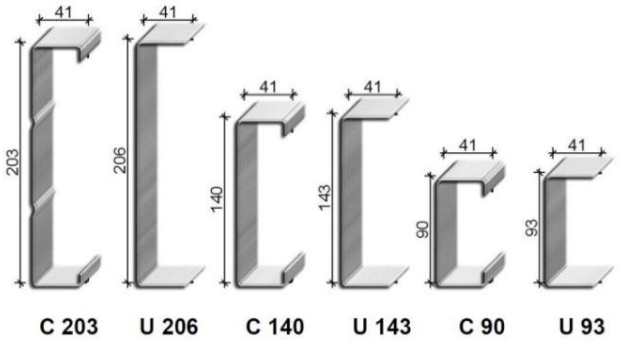
The solidified material is called polystyrene concrete. The durability of polystyrene concrete rivals that of conventional concrete.

LOAD-BEARING FRAME STRUCTURE

STEEL FRAME STRUCTURE

For Löglen steel frame structures 1.5 mm thick hot-dip galvanized steel is applied. In load-bearing walls and slabs “C” and “U” profiles are used in different sizes.

In case of steel frame structures Löglen buildings can be constructed up to 5 floors based on structural analysis.



LUMBER FRAME STRUCTURE

For the construction of Löglen lumber frame structures, lengthened, dried and laminated wood is used. Using lumber load-bearing structures, Löglen buildings can be built up to 3 floors based on structural analysis.

POLYSTYRENE CONCRETE

The polystyrene concrete used in Löglen system is produced through a special manufacturing process. The material structure enables the free flow of air and vapor through the walls, and it provides outstanding fire safety.

The technical data of polystyrene concrete are displayed in the table to the right.

Density	300 kg/m^3
Thermal conductivity	λ = 0.066 W/mK
Fire safety	8 cm < EI 90 A2 S1 d0 90 min – 240 min
Smoke production	MOD_{700} = 14.14 m^{2}kg^{-1}
Water vapor diffusion resistance	μ = 22

During construction, polystyrene concrete is used in the form of panels or granule. Polystyrene concrete panels are fixed onto the frame structure using screws and adhesive foam, while bulk polystyrene is poured into the wall or slab using an Estrich Boy machine. These are described in more detail at the structural elements.

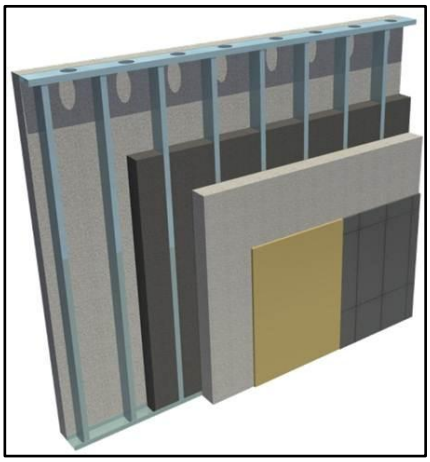
STRUCTURAL ELEMENTS

Hereinafter it is revealed how we get a building with excellent thermal parameters and homogeneous material structure free of thermal bridges, using Löglen technology.

WALLS

In case of Löglen Standard, basically there are three different wall sizes applied, with a slight difference in their structure, and in the thickness of the polystyrene concrete panels applied.

Technical data of 41 cm thick Löglen Standard wall structure	
Mass	145 kg/m^2
Thermal transmittance	U = 0.185 W/m^{2}K
Fire safety	REI-240, A2



The Löglen Standard load-bearing wall structure consists of the following: the polystyrene concrete panels – 15 cm thick outside, 12 cm inside– are screwed onto the 14 cm wide lumber or steel frame structure Polystyrene concrete is poured into the empty space between the profiles of the frame structure through the holes with 8 cm diameter in the top profile of the frame structure. In this case the polystyrene concrete panels serve as shuttering which is not removed afterwards, but remains to be a part of the wall. This way, we get a 41 cm thick wall.

The difference in case of the interior load-bearing wall is that on both sides of the frame structure 8 cm thick panels are placed, resulting in a 30 cm thick wall.

Dividing walls are very simple; they are made by gluing together 12 cm thick polystyrene concrete panels.

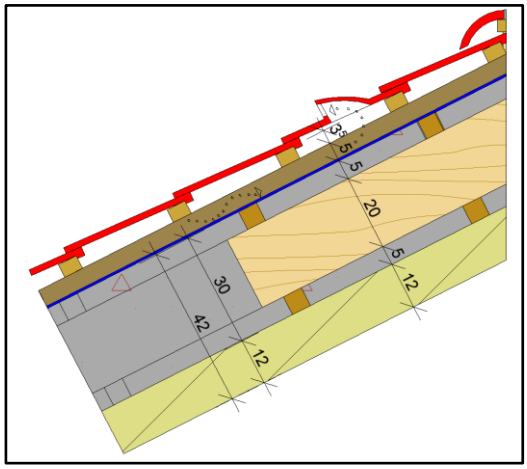
In addition, on both sides of the wall, gypsum plaster - reinforced with fiberglass - and plaster are applied.

SLAB

There are two types of slabs. One type is applied when there is no attic conversion. Then a non-load-bearing, but walkable slab is built. In this case, the slab is the bottom, horizontal part of roof truss structure.

Technical data of 39 cm thick Löglen Standard slab	
Mass	250 kg/m^2
Thermal conductivity	λ = 0.066 W/mK
Fire safety	REI-120, A2
Loadability	300 kg/m^2 <custom
Span	6.30 m <custom

In case of a load-bearing slab, 8 cm thick polystyrene panels are fixed on the bottom of 20 cm wide steel profiles. On top of the panels, a 20 cm thick bulk polystyrene concrete layer is poured. On top of all these, first a weight-distribution grid is placed then a 4 cm thick polystyrene concrete layer and a 5 cm thick estrich concrete layer is poured. The floor cover is placed afterwards.



ROOF STRUCTURE

The composition of Löglen roof structures depends on the purpose of the attic, provided there is an attic (flat roof).

In case of an unconverted attic, lumber or steel roof trusses are applied. On these, custom roof cover can be placed, according to the needs of the client.

In case of a converted attic, a layered, insulated Löglen roof structure is applied. This solution provides the same thermal parameters as the walls and that are characteristic of the entire building.

The roof structure is built up as shown in the picture above in case of a lumber roof structure and roof tiles. On both sides of the rafters there are battens, and on the bottom 12 cm thick polystyrene concrete panels are fixed, and in the space enclosed by the battens polystyrene concrete is poured (30 cm). On top a vapor permeable underlayment, counter battens, battens and the roof tiles are placed, in this order.

CERTIFICATES

Löglen has an ÉME (National Technical Approval), issued by the Hungarian Non-profit LLC for Quality Control and Innovation in Building (ÉMI), and its issue number is A-130/2010. The approval is issued based on complex examinations, experiments.

The examinations include every type of walls, slabs and roof structures, and all their components, from the polystyrene concrete through the frame to the screws. Fire safety, safety of use, health aspects, energy efficiency, etc. are examined. Löglen has met all the requirements established by ÉMI.

ADVANTAGES

Compared to conventional technologies, Löglen has many advantages, offering solutions for numerous challenges of today's construction industry. Hereinafter these advantages are described.

IDEAL WEIGHT

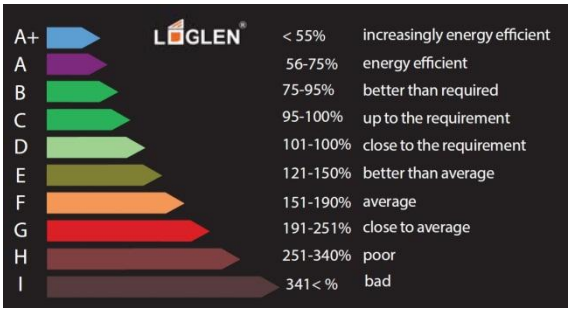
The walls of lightweight buildings weigh too little (30-70 kg/m^3), while buildings made from conventional bricks weigh too much (~1500 kg/m^3). The weight of Löglen wall structures is 300 kg/m^3. This weight can be called ideal from several aspects.

Due to the ideal weight, the transportation of the construction material to and on the site of construction becomes quite efficient. Furthermore, when building the foundation, 30-40% less concrete is required. The amount of material saved this way means a significant amount of money saved as well.

The table on the right displays a comparison with some construction materials found in the market.

Löglen Standard wall (41 cm)	300 kg/m^3
Brick wall (30-38-44-59 cm)	~1500 kg/m^3
Aerated concrete wall (37,5 cm)	800 kg/m^3
Traditional lightweight wall	80 kg/m^3
Loghouse wall	550 kg/m^3
Polystyrene walling block (no concrete)	70 kg/m^3
Reinforced concrete wall (25 cm)	2400 kg/m^3
Prefabricated wall panel(25 cm)	2400 kg/m^3

A+ ENERGETICS



Thanks to the outstanding thermal parameters of polystyrene concrete, the heat insulation and heat retention of Löglen buildings are exceptionally good. This applies to the entire building, since the homogeneous structure provides a thermal bridge free protection from the changes in the temperature of the environment.

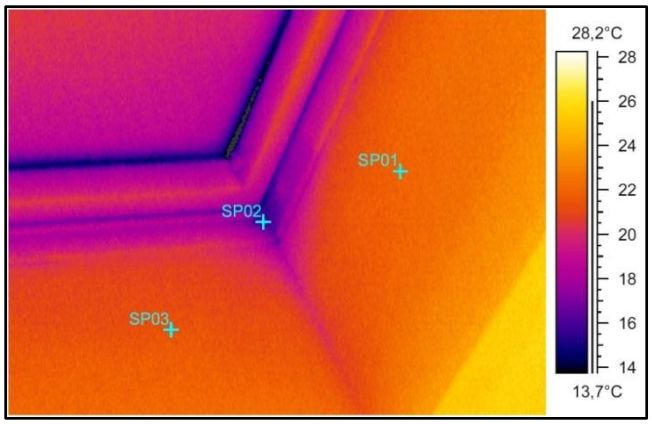
Since the material of the wall itself is excellent for insulation, there is no need for subsequent insulation in case of Löglen buildings. This means that two distinct work processes of the construction are covered in one step. The 41 cm thick Löglen Standard load-bearing wall has a thermal transmittance of U = 0.185 W/m^{2}K, and a thermal conductivity of λ=0.066 W/mK.

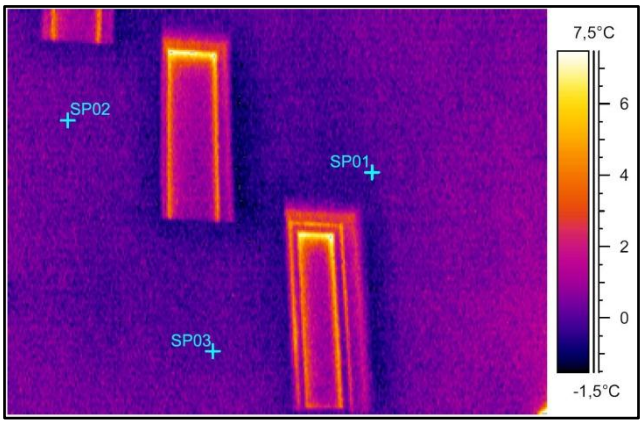
This way, Löglen buildings can easily achieve the A+ energetic qualification, meaning that these buildings are increasingly energy efficient. Both their heating and cooling requirement is lower, which leads to cost-effectiveness and sustainability in the long run.

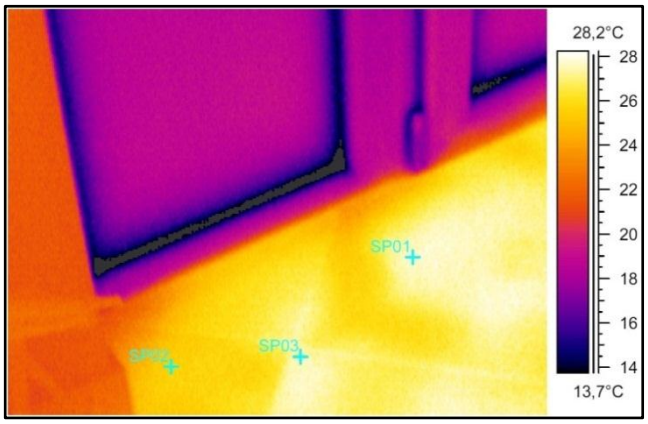
Beside the fact that conventional heating and cooling systems can be operated economically, Löglen system supports the use of renewable energy sources and the related investment returns sooner.

THERMAL BRIDGE FREE

The pictures below display that Löglen buildings are thermal bridge free. These thermal photos were made in the winter, with an outside temperature of about 0°C. It can be seen that from the aspect of insulation, doors and windows are weak points. However, Löglen walls provide thermal bridge free insulation even directly around windows and doors.





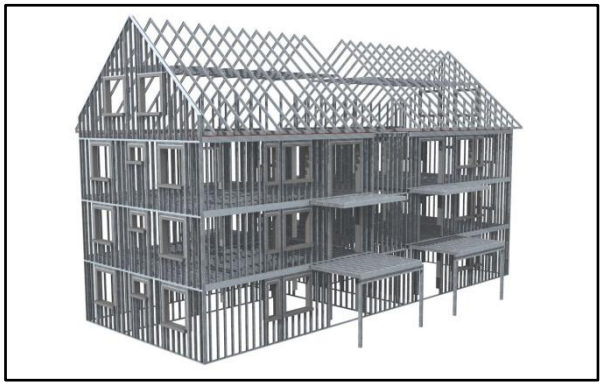


AGAINST DIFFERENT LOADS

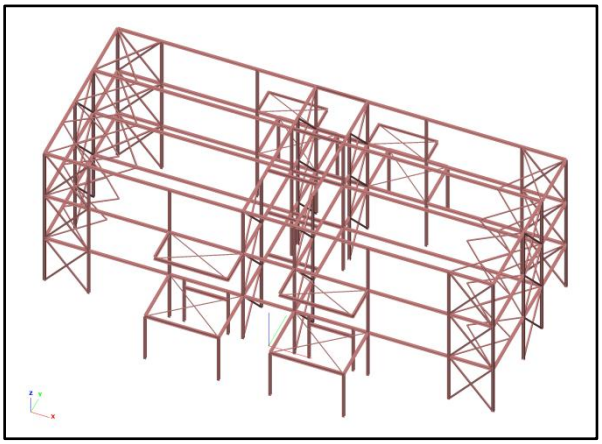
With the help of software that executes spatial stability analyses among other things, structural calculations have been made for every building built with Löglen technology, including a sample building. In the case of the sample building the forces have been observed under snow, wind and earthquake conditions characteristic of Hungary.

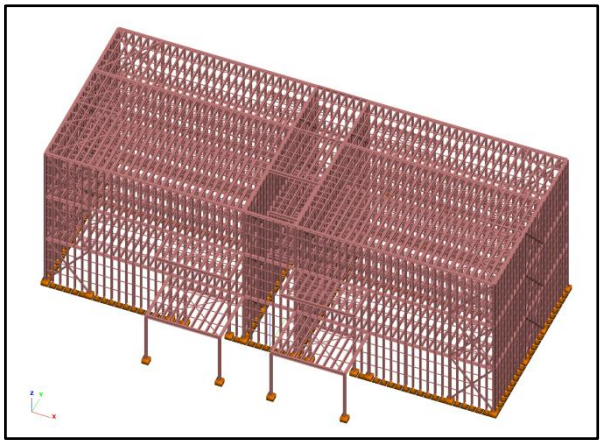
The software simulates the movements of the structure of the building under different loads and their superimpostitions as well. The following illustrations show the results.

The four-story building consisted of three floors and a converted attic, as shown in the pictures below.

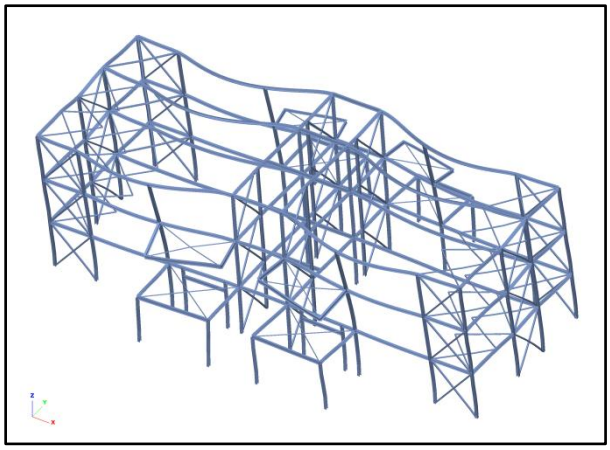


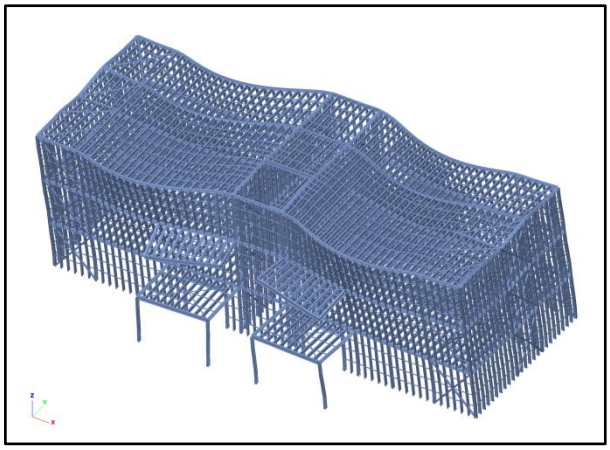
The following two pictures show the main structural frame (left side) and that together with the slab beams and wall columns (right side).



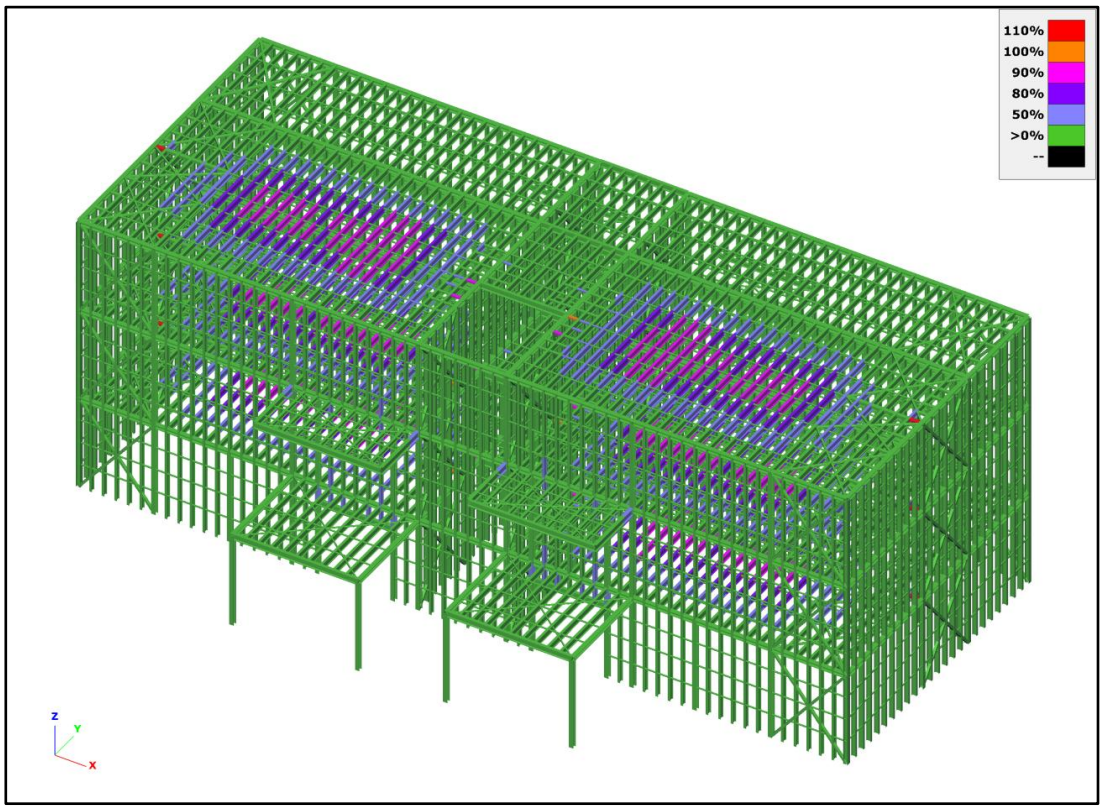


The two pictures below display how the main structural frame and the complete structure look during an earthquake. We can see that it flexibly absorbs the tremors.

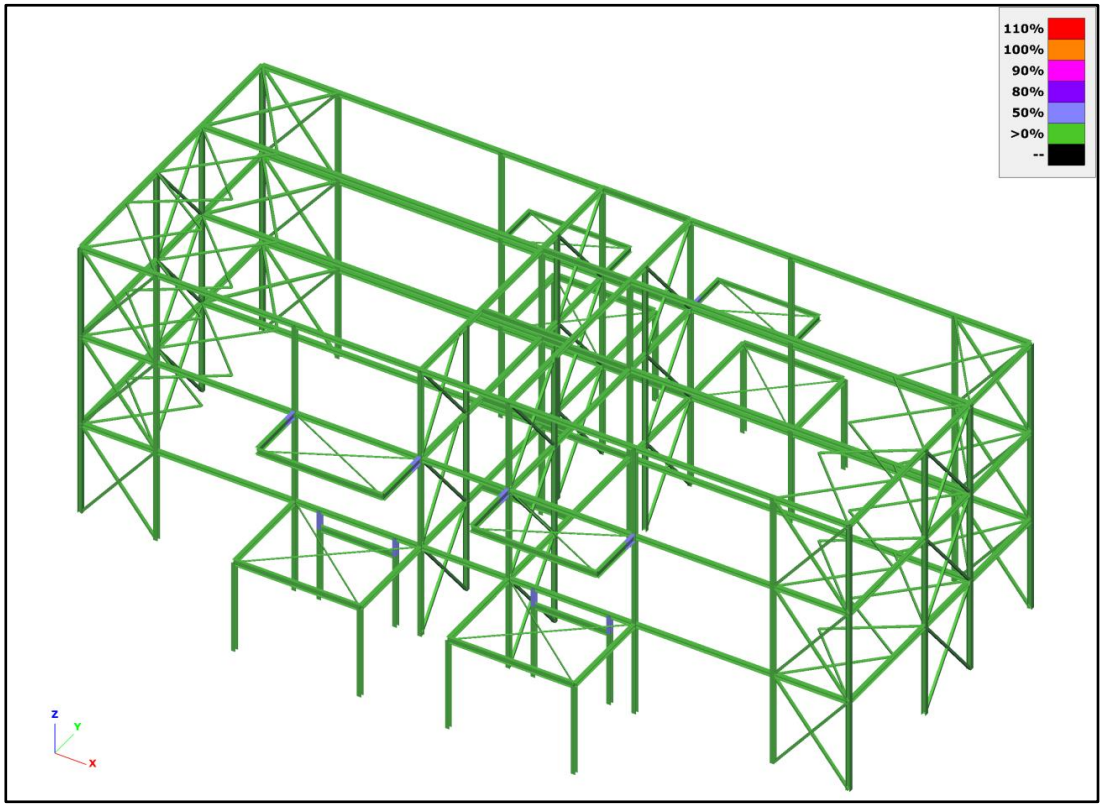




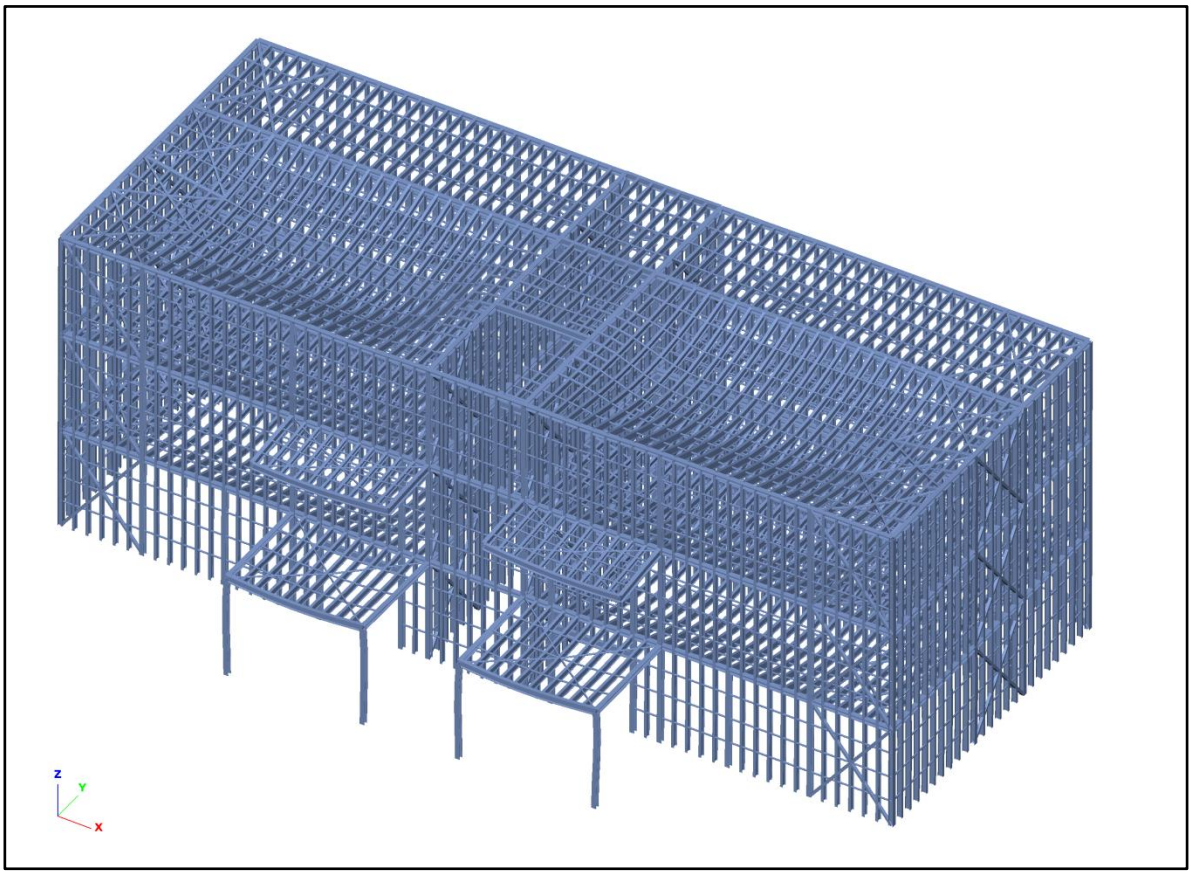
The next picture shows the utilization of the entire structure. It can be seen that the Löglen slab beams and wall columns placed in the steel frame comply with the loads.



Now, let us examine the impacts on the main structural frame. It can be seen that in this case the pieces of the main structural frame serve as reinforcement and columns for corner and 'T'-shaped wall connections, providing stability for the building against different impacts, like earthquakes.



The following picture shows the deformation created in the structure of the four-story Löglen building after the tremor.



We can conclude that buildings built with Löglen walls and slabs up to low heights (2 floors), under Hungarian conditions (p_s = 1.00 kN/m^2, v_{b0} = 23.6 m/s, a_{gr} = 0.12*g) can stand potential impacts without a separate reinforcing steel frame. In case of more floors, the application of a separate steel frame can provide the proper load capacity.

In case of different conditions – more snow, wind, earthquake – with the proper layout and the use of reinforcing structures, buildings can be made to stand the given impacts completely, and the characteristics of Löglen structures can be utilized.

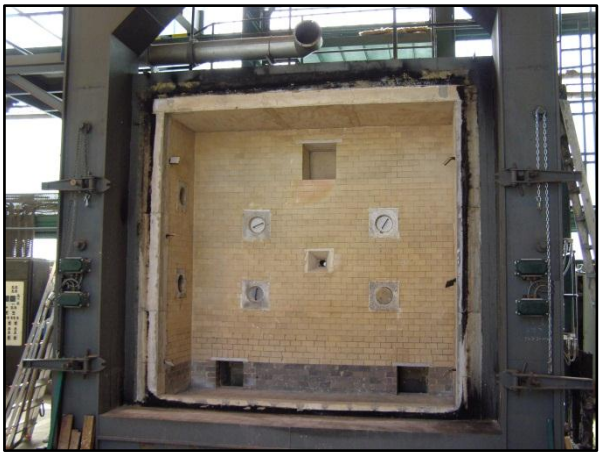
FIRE RESISTANT

Another potential source of danger concerning buildings is fire. Löglen wall structures are very good in terms of fire safety as well, they provide protection from the flames for a sufficient amount of time.

As was mentioned at the certificates, the strict examinations included fire resistance as well. The results will be described below. The 30 cm thick and 41 cm thick Löglen load-bearing wall structures -with and without fire-proof plaster –were submitted to an intense burning test, and the slab was also examined. These examinations will be shown in more detail illustrated with pictures.

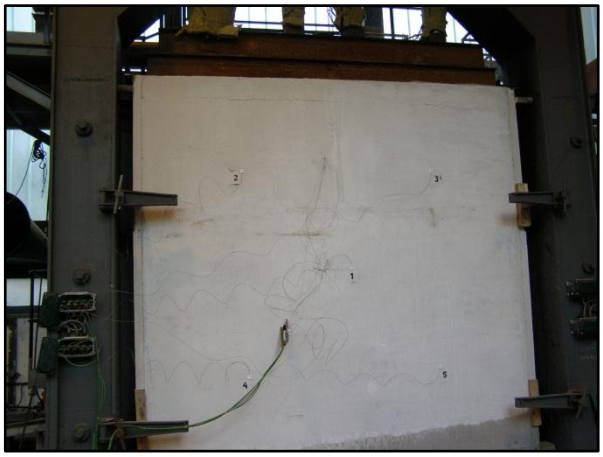
First the fire test of the 30 cm thick wall structure is presented. The incineration lasted for two hours, without pause, the temperature of the fire reached 1000°C. In the pictures, it is displayed how the wall structure stood against this degree of incineration.

In the picture below (left side) the wall can be seen prior to the incineration. The other picture (right side) shows the incinerating equipment, before the placement of the wall.



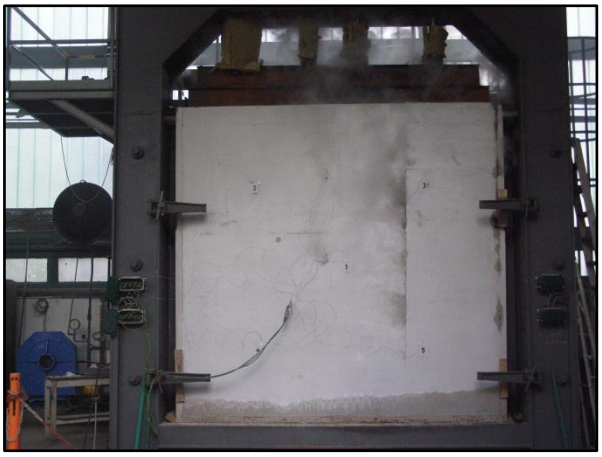
The following pictures depict the different stages of the examination.

It can be seen, that after 19 minutes, at a temperature of about 800 °C there is no significant change in the wall structure.



After one hour and ten minutes some cracks have appeared, and smoke started to leak through the wall. Nonetheless, this side of the wall is still safe, the wall keeps the flames at bay.

After nearly one and a half hours, we can see that the smoke is leaking through several cracks in the wall, and the temperature is at 1000°C, but the wall still holds.



Near the end of the experiment, at 1046°C, we can see that in the middle picture below, on the right side of the wall, there is a strong leakage of smoke, while the left side is still left visibly undamaged. Also, we can observe (rightmost picture) that the wall has bulged due to the long lasting pressure.

Examining the wall structure after the test is performed, we can see what damages have been done to the wall. The pictures speak for themselves; the wall has met the fire protection criteria, and it has complied with the required values.

The fire test of the 41 cm thick wall happened in a similar manner, but it lasted for four hours instead of two. By the end of the fourth hour the temperature exceeded 1100°C. The process was similar to the previous one in many ways, so only a few pictures are shown below.

The incinerated side of the wall was covered with fire-proof plaster (top left picture, taken before the examination). The top right picture was shot after almost four hours of burning. We can see the screen at four hours, showing the actual temperature as well, while in the bottom right picture, the condition of the wall is shown after the examination after breaking the cover ourselves to see that the steel structure and even the galvanized surface was completely undamaged.



The two-hour long slab burning is depicted with only a few pictures. The 39 cm thick slab also complies with the fire safety regulations. In the case of the slab, there was no fire-proof plaster applied, the temperature reached 1000°C in this case as well.

In the pictures (from left to right) the slab can be seen in the beginning and at the end of the examination, and its condition after the examination is displayed.



The slab, and the 41 and 30 cm thick walls have complied with the fire safety regulations.

HEALTHY AND ACCOMMODATING

Buildings built with Löglen technology provide an exceptional feeling of comfort, since the walls are not only great in terms of insulation, but they have very good vapor and air permeability (vapor diffusion resistance factor: $\mu = 22$) due to the material structure of polystyrene concrete.

In an inhabited building during everyday life, a lot of vapor is produced. This vapor comes from the human body, the bathroom or kitchen, or from clothes drying after washing or it can be generated during cooking, cleaning, etc.

In the case of buildings built with conventional technologies, this vapor often condenses inside the walls which results in molding and mycosis that are quite harmful for health. However, in the walls of Löglen buildings, this vapor cannot condense, it escapes through the wall structure without a problem.

Furthermore, the free flow of air creates the feeling of being outside in the fresh air all day long, but in the meantime, the building provides protection from the outside temperature and the extreme behaviors of the weather. The climatic comfort of Löglen buildings is ideal, even under extreme conditions.

FAST

Löglen buildings can be built very rapidly due to several things. Let us begin with the handover of the approved building plans.

Based on these plans, with the help of the proper software a production plan is made which tells us the exact required amount of every material needed for the construction of the structure of the house. This way, the exact amounts can be produced. After this, the frame and roof structures are preassembled so they are transported to the construction site in bigger pieces. The polystyrene concrete panels and granule can also be transported easily, and with the easy transportation, a lot of time can be saved.

The production plan is a big help not only in production, but in the assembly as well. With its help, the preassembled pieces of the frame and the polystyrene concrete panels can be put together very rapidly by 5-6 people.

If the construction site allows it, the pieces of the roof structure can be assembled on the ground, and then it is placed in bigger pieces, which also expedites the process.

The fixing of the polystyrene concrete elements also progresses quickly, since the panels are relatively big, they can be moved easily, and they are fixed easily with screws and adhesive foam. The pouring of the bulk polystyrene concrete into the corresponding spaces is accelerated by the use of Estrich Boy machines.

The installation of pipes and wires is quick as well, due to the formability of the material. As a result, Löglen structures can be constructed in 10-20 days by 5-6 workers.

EXCELLENT FORMABILITY

The material of Löglen buildings is easily formable, as mentioned before, which makes the work of building engineers easier and faster. Formability, however, is displayed in another field as well. It provides great flexibility in terms of design. Polystyrene elements can be used to create leaning shapes, interior and exterior decoration and any creative ideas can be realized with them. For instance, the piece cut out for the door in a dividing wall is commonly utilized as the counter for sinks. These solutions are displayed in the pictures below.

ECO-FRIENDLY

Speaking of any product nowadays, it is important, or even required that it should be eco-friendly. Löglen is outstanding from this aspect. The raw materials themselves (polystyrene concrete, lumber, steel) are not harmful for nature.

In terms of quickness, we have already mentioned that transportation is efficient. This decreases the impact on the environment, since 4-5 trucks are enough for the transportation of the material of the entire building structure (in case of buildings of areas 100-300 m^2).

Furthermore, due to the production plans, since the material requirements of the buildings are determined very punctually, the exact amount is transported, and this way, the amount of waste produced during construction is minimized.

It is important to mention that since Löglen buildings are energy efficient, above the fact that you have to pay less monthly for heating and cooling, the harmful impact on the nature is also decreased. The CO^2 emission of

Löglen buildings is low as well, in case of a house of 100 m^2 and the use of a condensing combi boiler, it is 1.57 t/year.

100% REUSABLE

Löglen buildings are 100% reusable. Löglen structures consist of two-three main materials: the material of the frame structure (lumber and/or steel, including the walls and the roof) and polystyrene concrete. All of these are reusable.

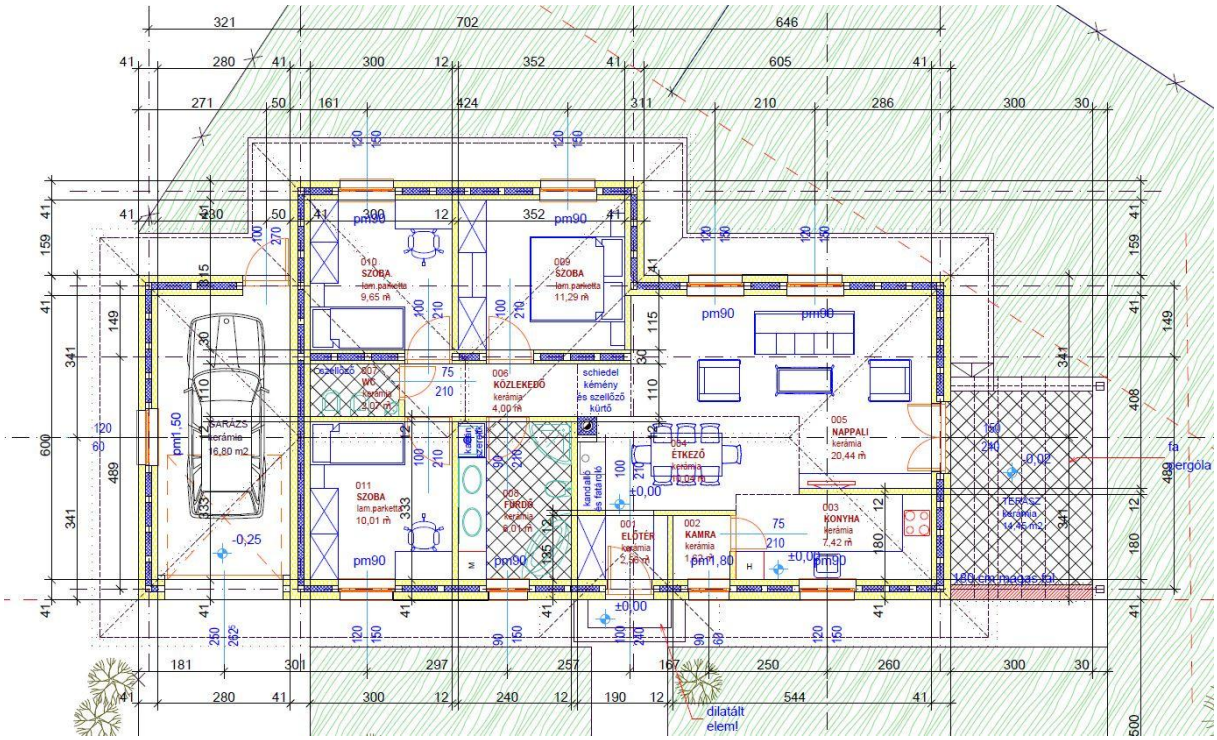
In the case of lumber and steel, waste can be generated during production and the preassembly of the pieces of the frame structure. There are appropriate methods for recycling this waste. In the case of polystyrene concrete, the production can be a recycling process in itself.

In the production of polystyrene concrete, we may use EPS beads supplied by a manufacturer (right side of the image on the right), which are expanded, and that is how they serve as raw material for polystyrene concrete. The other alternative is to reuse polystyrene packaging and insulating materials (left side of the image on the right).

Polystyrene is commonly used as packaging material of electronics, or external insulation for buildings. There is no appropriate method for handling the waste created this way. However, this material – ground and sorted – provides excellent raw material for polystyrene concrete production.

On the construction site, there is no waste from the frame structure, since the pieces are transported based on the production plans and they are all used up in the assembly of the frame structure. In the case of polystyrene concrete, some waste may be generated, but that is immediately used up together with the bulk polystyrene when pouring the slab, as illustrated in the pictures below.

KECSKEMÉT – NYITRA STREET – RESIDENTIAL BUILDING



Above, the building design and floor plan of the house at Kecskemét can be seen (with Hungarian labels).

Below we are going to present the annual energy consumption of a detached house with Löglen structure located in Kecskemét, Hungary. Basically in this part, we provide more details on why it is advantageous if a building is increasingly energy efficient, rated A^+.

The heated area of the house (garage excluded) is 87.1 m^2; the total surface bounding heated spaces: 281.4 m^2; the heated volume of air is: 235.2 m^3. Due to the excellent insulation, the outside temperature at which the heating system is turned on – instead of the national average of 12°C – is 7.4°C. Consequently, the length of the heating season in the case of this house is 138 calendar days instead of the average of 180 days annually.

The heating system includes the following: condensing boiler operated by natural gas, radiators in the rooms, towel drying radiator in the bathroom and underfloor heating in other rooms. Considering all the factors included in the calculations, the annual energy requirement of heating is 37.42 kWh/m^2/year.

Domestic hot water system: electric air source heat pump (C.O.P. = 3.7), pipeline system is inside heated space, there is no storage loss and circulation. The annual energy requirement of hot water supply is 18.25 kWh/m^2/year.

All summed up, the annual energy requirement of the building is 55.68 kWh/m^2/year. The maximum value is 217.57 kWh/m^2/year. A building achieves A+, increasingly energy efficient rating if the total annual energy consumption is below 55% of the maximum value. Based on the above, in the case of the detached house in our example this value is 25.6%.

In the calculations above, Hungarian conditions were taken into consideration, and the focus was mainly on heating.

RESIDENTIAL BUILDING OF KECSKEMÉT IN WARM CLIMATE

Hereinafter we are going to present how the same building, with smaller changes, would perform in the extreme conditions of a desert. In case of Hungary, we only had to consider heating, but we should examine the possible solutions that can be applied in extreme hot weather, where mostly cooling is needed.

In a desert, there is extreme hot and dry weather. This comes hand in hand with the fact that the daily temperature can exceed 50°C, while the temperature at night can drop near 0°C. We have inspected how the energetics would change taking these factors into consideration.

We wish to keep the temperature inside at 26°C. Due to the cold nights and hot days, we have included a heating-cooling fan coil system.

The domestic hot water is supplied by an Ariston air source heat pump (C.O.P.=3.7) or solar collectors.

Furthermore, the roof structure should stretch out to at least 100-120 cm, and the proper shading (shutter, heat reflective sheet) that provides protection from the heat of solar radiation is essential for favorable energy consumption and a pleasant feeling inside the house. This way, the need for cooling is minimal, about 25% compared to houses built from conventional construction materials.

The results for the annual energy consumption of heating and cooling is 27.94 kWh/m^2/year, the annual energy requirement of DHW is 5.00 kWh/m^2/year. The total annual energy consumption is therefore 32.94 kWh/m^2/year.

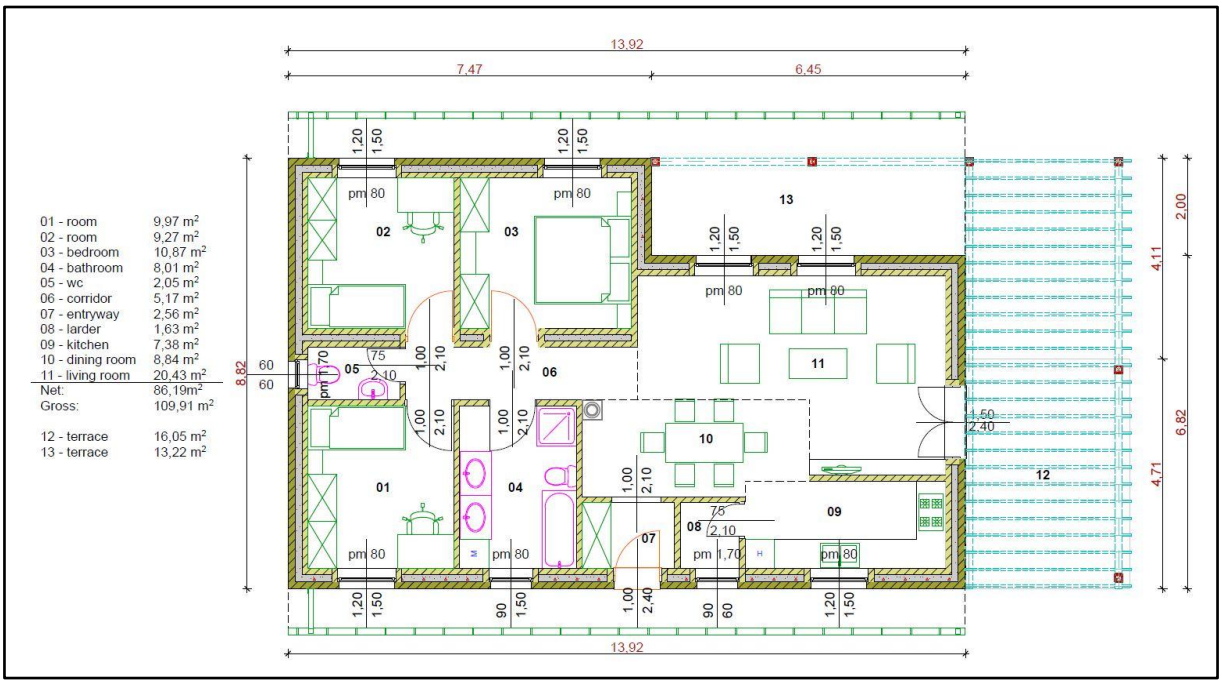
Under the conditions above, the maximum value of energy consumption is 175.2 kWh/m^2/year, and based on that, the total energy consumption is 18.8% of the maximum value.

DEMO HOUSE IN TURN-KEY CONDITION

Hereinafter a demo house is presented, which could be constructed in Oman, on order, based on the above. The building designs below show how the house would look.




Below, the floor plan can be seen, with the locations of the rooms.

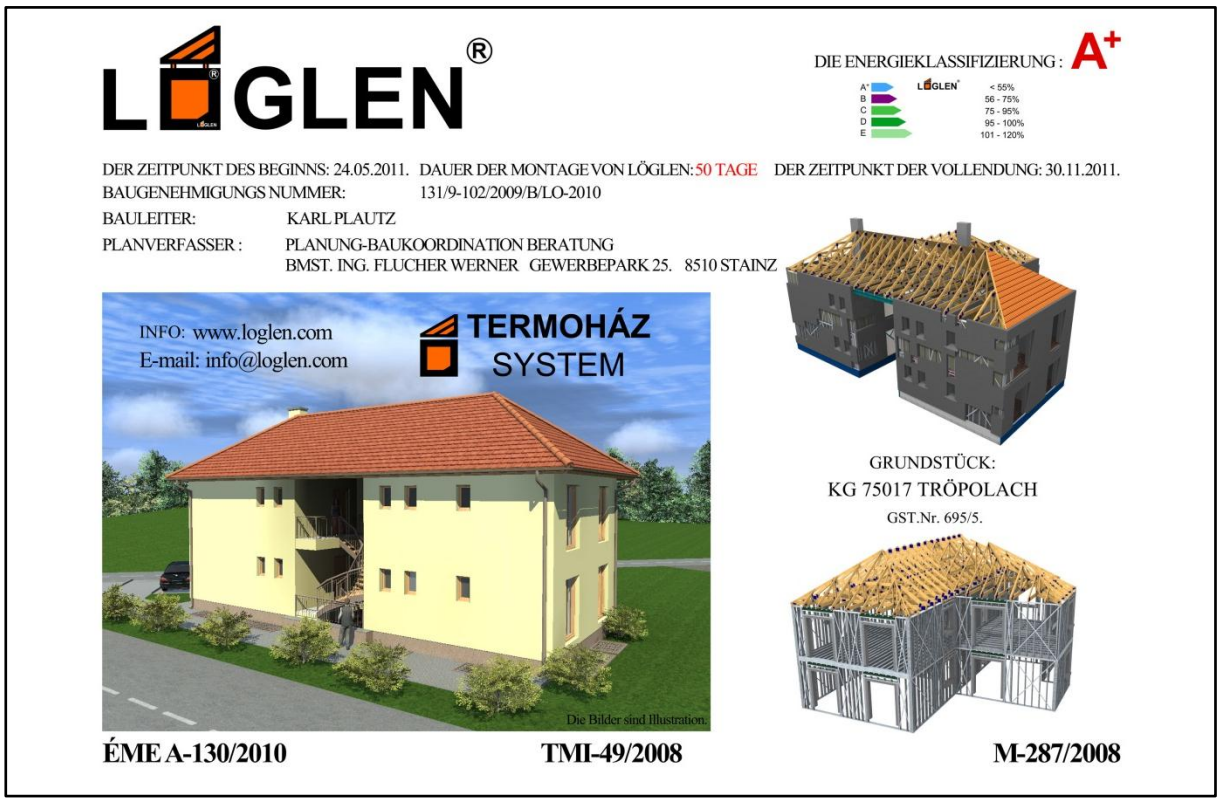


In turn-key condition, the house contains the following, complying with EU standards:

- Complete building structure (walls, roof), including all their parts (as shown in the description of the structural elements)
- Internal and external doors and windows + shading
- Windowsills
- Chimney
- Electrical installation
- Building engineering
- Sanitary ware
- Wall and floor covers (wood panels, ceramic tiles, etc.)
- Internal and external wall paint
- Gutters and downpipes
- Pergola
- Colored roof tiles
- External wastewater storage

REFERENCES

AUSTRIA – TRÖPOLACH



FONYÓD – EXTERNAL INSULATION, ATTIC CONVERSION AND RENOVATION

SZADA – DETACHED HOUSE – LUMBER STRUCTURE

TÖRÖKBÁLINT – DETACHED HOUSE – STEEL STRUCTURE

PÁTY – DETACHED HOUSE

The video with live pictures about the detached house with steel structure built at Páty is available on the following link: http://youtu.be/hgOWSCSQrbI

ZSANA – PUBLIC BUILDING

LEGAL PROTECTIONS

PATENT

A patent is a form of intellectual property protection. Löglen technology is a new invention, and it is protected by international priority patent against copying. Its international patent application number is PCT/HU2009/000093. The patent on Löglen technology provides long term exclusivity on the market. Along with all its advantages the patent provides a long term competitive advantage over other technologies.

BRAND

Löglen technology and Löglen houses are unique on the market. The Löglen brand name is meant to enhance this uniqueness. Two illustrations belong to the brand name, which can be seen below. The Löglen brand is under trademark protection. Our aim is that if anyone hears the name Löglen, they should immediately think of A+, energy efficient houses that were built with this unique technology.

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SUMMARY

Löglen technology offers a construction system which combines the beneficial thermal parameters of polystyrene concrete with the load-bearing ability of steel and lumber structures. Together these form a thermal bridge free, homogeneous structure.

The technology has all the certificates required for construction, and it has many advantages over the competition. This technology offers a solution for several challenges of today's construction industry. The weight of the construction elements is ideal, they are easily formable. The buildings have low energy consumption; they fare well against different loads and fire, and they are healthy, with splendid climatic comfort. The technology enables fast construction, and it is eco-friendly.

The technology is patent protected, which provides exclusivity for magnificence, and it is paired with the Löglen brand, which helps identification.