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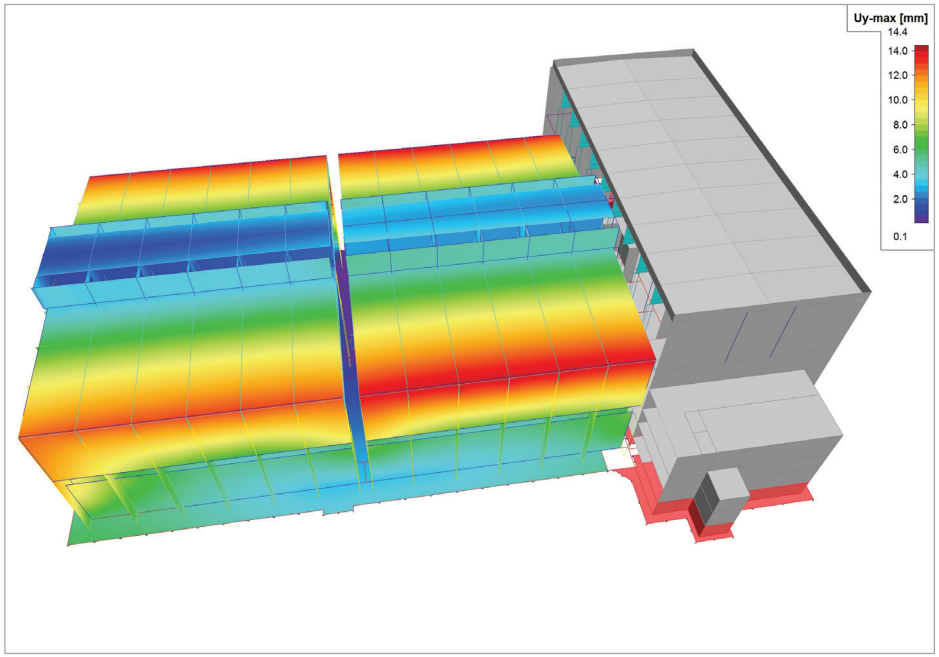
Winner

STATIKA®

STATIKA Company Ltd. was founded in 1998 and today it is one of the leading engineering companies engaged in the design and assessment of load-bearing construction works, engineering and construction of bridges in all material variants.

We use the latest design of computational methods. In addition, we provide services of forensic engineering for constructions with the focus on static and dynamic structures. This activity allows us to get feedback in the design of structures. A part of our professional staff also gives lectures at professional conferences. The company is divided into various departments: concrete structures, steel structures, foundations, bridges and engineering design, allowing designing structures in all material variants.

Each section works under the leadership of experienced structural engineers, creators of many interesting structures. We design the construction from the conceptual design to the working design, up to the delivery of the construction documents. Our designs meet all economic, aesthetic and utility requirements.



Software: Nexis, Scia Engineer

Warehouse for Spent Nuclear Fuel - Temelín, Czech Republic

Description

The warehouse is divided into two parts, the receiving and the storage unit. The building is a monolithic reinforced frame structure with a precast monolithic roof. The storage part measures 46.7 x 74.0 and has a height of 24.30 m. The receiving part is 25.5 x 67.0 m large and has the height of 25.85 m. The foundations are designed as two-segment robust concrete foundation strips, which together create a solid base grid. The roof construction is designed in the prefabricated monolithic version. The precast girders are not supported when concreting slabs and girders to carry the weight of formwork and concrete.

Conceptual design and structural analysis

The structure is designed according to international standards for nuclear power plants, which are superior to the standard EC and which represent a very large set of standards and regulations.
Basic and special combinations of loads are considered under the provisions of IAEA-TECDOC, NS-G and others. The basic combination considering the dominant load: loading cranes, wind, snow, normal loads and operating temperatures.
The accidental design combinations are considered separately in combinations with a constant load:

- Seismicity load - the maximum calculated earthquake (level SL - 2 according to the IAEA). The repeatability of these values is 10.000 years, probably not exceeding 95%.
- Aircraft impact load - a light aircraft crash accident, weight 2.000 kg and 200 km/h is defined by impulse 2.2 MN, pulse duration is 34 ms.
- Extreme wind load - 68 m/s.
- Extreme snow loads -1.60 kNm-2.
- Extreme temperature loads - the maximum annual temperature + 45.6 °C and minimum annual temperature of - 45.9°C.
- Explosion load - load pressure on the head shock wave 6 kPa.

For global static and dynamic analysis several 3D and 2D models were created in Scia Engineer and Nexis (ESA-Prima Win). We also carried out a check of results in other reference software, with a view to increasing the safety of the design for building nuclear power plants.

The building was modelled alternatively as a whole, Receiving + Storage section, and as a separate Storage and Receiving section. Objects were modelled as bars + walls - plates (Mindlin model). Plate-wall elements were used for larger columns and trusses, alternative models of columns and beams were modelled as bar elements that act as T-sections. For T-sections, the relevant forces of the slab/wall were integrated into the ribs. An integral part of the modelling was the nonlinear behaviour and the calculation of gradual execution, with consideration of shrinkage and creep of concrete. The structure has been solved in the interaction with the subsoil. The foundation structures were supported by the “Winkler - Pasternak” subsoil model with boundary conditions depending on the “Kolář - Němec” model. Subsoil values were determined by interaction and the check was carried out in Soilin.

For the dynamic analysis modified 3D and 2D models were used. The dynamic analysis was calculated for 100 eigen modes and frequencies, which lie in the frequency range 1.80 Hz - 13.3 Hz. Seismic actions were determined by the decomposition of the seismic eigen modes (modal analysis). When designing structures for nuclear power the NUREG spectrum has to be used. Seismicity, except for areas of very strong seismicity, belongs to a group of accidental loads. In this design it is almost always necessary to use plastic reserve design when considering the ductility of the structure. Load due to the aircraft impact has been solved by the response to a general dynamic load, so-called direct integration. At the same time the dynamic impact was transferred to a quasi-static action using the theory of soft-plastic impact with the oscillating mass of the structure taken into account. In the design of girders the redistribution of forces due to different shrinkage of older prefabricated trusses and monolithic slabs and the effects of rheology of statically indeterminate structure were considered.

Conclusion

The construction of the SSNF is very complicated in terms of design. Quality building construction meets the demanding requirements of the project. The option of the monolithic variant with precast-monolithic roof is a competitive alternative to prefabricated options used abroad.

Warehouse for Spent Nuclear Fuel

Temelín, Czech Republic

Project information

Owner	ČEZ, a.s.
Architect	ÚJV Řež a.s., divize Energoprojekt Praha
General Contractor	CEEI s.r.o.
Engineering Office	STATIKA s.r.o.
Construction Period	From April 2009 to September 2010
Location	Temelín, Czech Republic

Short project description

The presented project is a warehouse for the storage of spent nuclear fuel (SSNF) in the nuclear power plant of Temelín. A lot of Government Building Resolutions had to be taken into account. The building is a solution at the end of the fuel cycle, before placing the fuel to a deep repository. The warehouse is divided into two parts - the receiving and the stock unit. The concept of the structure is specially designed according to the international standards for nuclear power installations, which take precedence over the national standards ČSN EN. The standards are very complex and comprise many rules and regulations.

Quote of the Jury

"The project was chosen because of the complexity of special load cases, such as seismic loads, aircraft impact and explosion loads. Also the nonlinear behaviour, the calculation of gradual execution and the interaction with the subsoil added to the high technical level of the project."