CASE: Loviisa Water Tower; Design and Analysis using BIM tools

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Zusammenfassung:
Die Stadt Loviisa, Finnland hat ein Architektur Wettbewerb organisiert um eine neue, innovative Lösung für ihren Wasserturm zu finden. Architect Markus Pernthaler aus Österreich hat die beste ingenieur Kräfte in Finnland kontaktiert und das war der anfangspunkt für unser erfolgsreihe Lösung. Von anfang an war es Klar dass nur die beste Softwares Nötwendig waren. Analysis wurde mit dem Sofistik und 3D modellierung und Bewehrung mit dem Tekla Structures gemacht. Das Ergebnis war ein Zuverlässiges und Ökönomisches Entwurf. Das Projekt ist jetzt im Ausschreibung Phase und wir versuchen gleich so innotavive Baufirmen als das Entwurf ist zu finden.

Summary:
The City of Loviisa, Finland organized a architectural competition in order to find new innovative solution for their new water tower. Austrian architect Markus Pernthaler contacted best forces in Finland and so was this winning solution started. From the beginning it was clear that also best software should be used. Analysis was made with Sofistik and modeling and reinforcement with Tekla Structures. Result was reliable and economic design. Project is in tender face now and we are trying to find as innovative builders as the whole building is.

Picture 1 Location

1 CONTENTS

1.1 Backround

The Project was initiated in 2010 by the city of Loviisa. They organized an architectural competition and the aim was to achieve new innovative design for their new water tower. The existing tower was from the 60's and in the need of repair. Location of the tower is on the small hill next to the city center and facing towards the see.

Picture 2 Real model in scale 1:200

1.2 Project

The project was iniated right after the selection of the winner. Our design group consisted of Finnmap Consulting as structural designer and project management, Architect Markus Pernthaler from Graz, Austria as architect and Airix Oy (also part of FMC Group) taking care of water techniques, HVAC design and area design.

It was recognized already in the beginning that this is no easy task. As we noticed along the way, different and unconventional needs of different needs caused extra worries during the way.

Although we are talking about water tower, different kind of fire protection requirements became a challenge. You cannot simply open a valve and let the water flow. Also personal safety was an issue. It was designed on the top area for 40 people and they must be able to save in case of emergency. Different solutions were discussed varying from coming down by a rope or helicopter. Chosen solution was staircase with spinklersystem, intermediate platform for Loviisa City fire department rescue ladder truck and separated sections for smoke and fire protection.

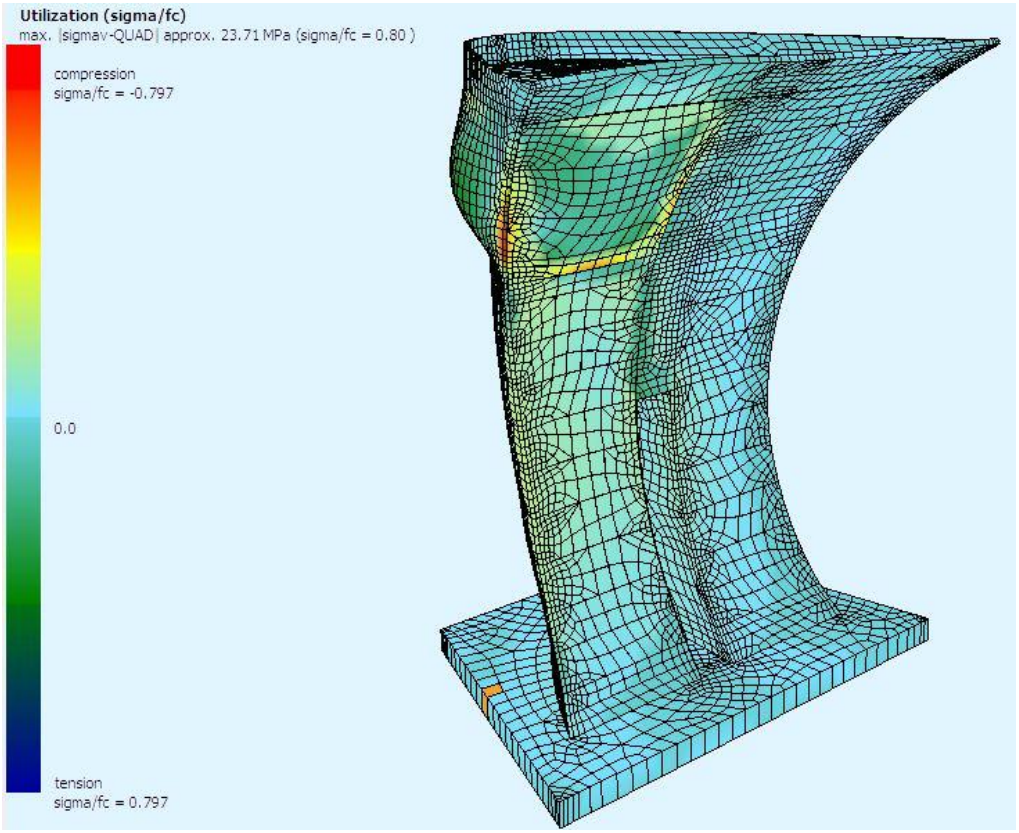
1.3 Modeling and Analysis

It was clear from the beginning that the only way to get this kind of complex geometry designed is 3D design. Different parabolas and radius would have been almost impossible to create without proper tools.

The geometry was produced first with Tekla Structures software. This means in the beginning mainly surface and geometry. Information from this model was then used to create analysis model in Sofistik.

All tendons and soil properties were modeled in Sofistik. Different load cases were analyzed and reinforcement plots were produced. Also all deflections and stress diagrams were produced.

Reinforcement principals were created with AutoCAD and some preliminary reinforcement design were made with Tekla Structures.



Picture 3 Stress

1.3.1 Loads

Main load case for this kind of structure was wind and partial water load. It was set as a requirement that one of the water tanks must be able to be empty for service etc.

Code used in this project was Eurocode with national annex.

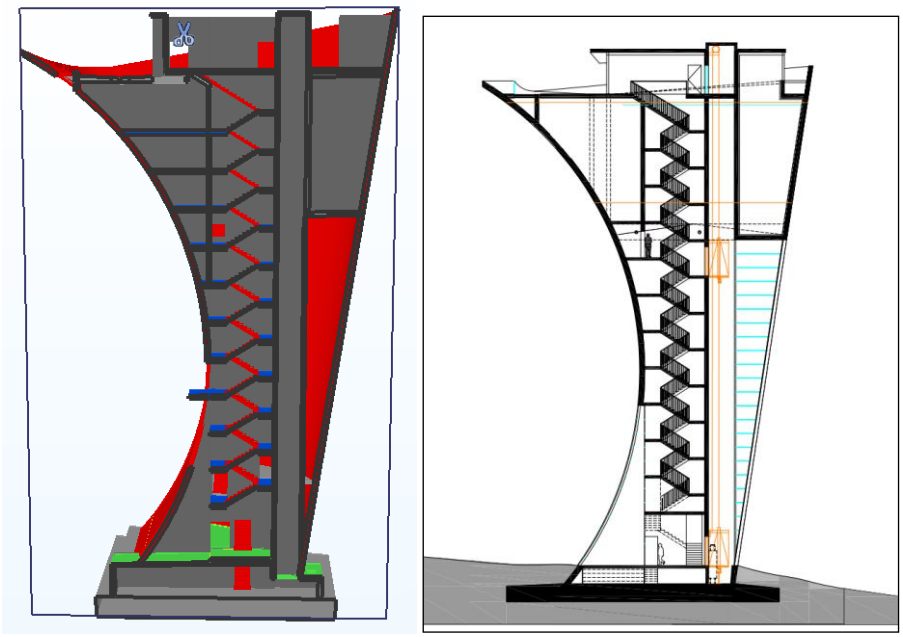
1.3.2 Structure

The tower itself is founded on thick layer of consolidated sand. Allowable stress was 300 kPa. For the Stability of the structure it was necessary to have thick and large base slab. Some of the technical spaces are located inside base slab.

Walls in lower part are conventional reinforced concrete walls. The requirement of 100 years life cycle gave criteria for cracking and for the concrete mix. The central core is concrete staircase with precast elements (stairs). The upper part of the tower (tanks) is prestressed (post-tensioned) concrete structures. Water tightness is guaranteed by inserting a HDPE plastic coating on the inside.

On the top of the building there is place for sightseeing, conference area and sauna and small pool.

Inner core area is also planned for climbing wall.



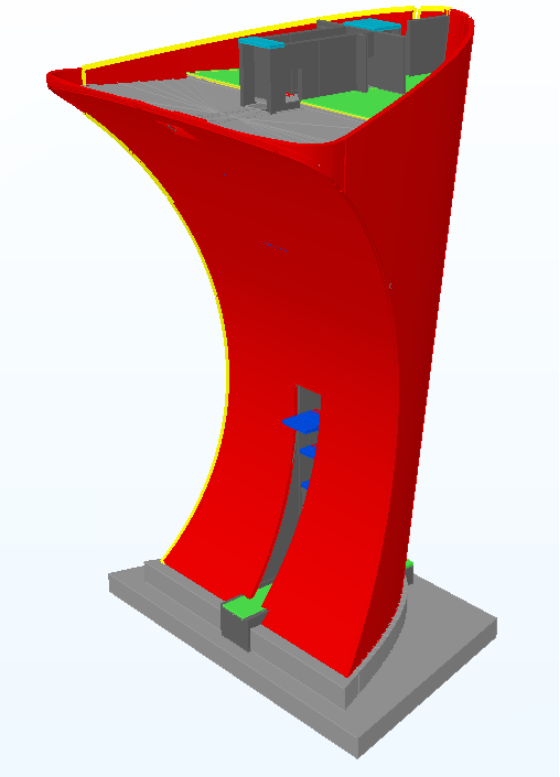
Picture 4 Structural and architectural point of view

1.4 Feedback and Status

The design has woken nationwide interest. New towers are build relatively rarely nowadays.

Difficult geometry has given worry on construction costs. However or design is based on central core made with self climbing formwork. Also outer shell was originally designed to be made with self climbing formwork in order to avoid costly support structure.

Despite interest it seems that traditional construction companies are too conservative to be able to construct this kind of geometry without excessive additional risk reserves. The project is in hault right now and we are trying to help the customer to find economical solution



Picture 5 3D view from Tekla

Picture 6 Architectural presentation

2 COMPANY

FMC Group is a dynamic planning group specializing strongly in structural engineering, building services, industrial and energy technology, environmental and civil engineering technology and expert services. We provide project services globally.

3 LITERATURE

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[2] *SFS-EN 1991* Eurocode 1: Actions on structures

[3] *SFS-EN 1992* Eurocode 2: Design of concrete structures

[4] *SFS-EN 1997* Eurocode 7: Geotechnical design

[5] *Building SmartFInland:* General requirements for BIM in construction project