

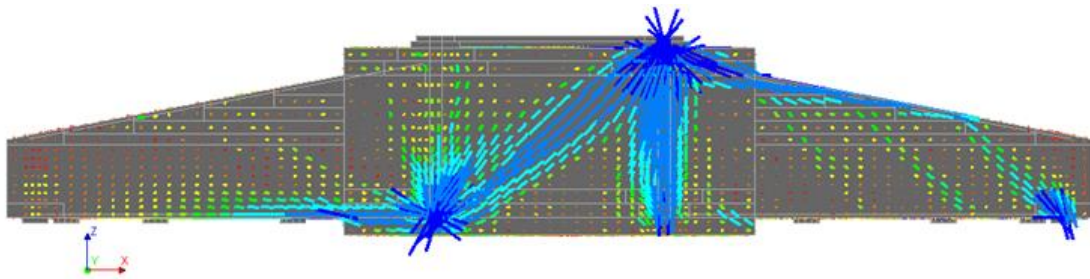
Nonlinear 3D modelling for wind turbine foundation design

Windbase is designing its wind turbine foundations using advanced nonlinear 3D FEM models since 2006. And for good reasons...

The structural behaviour of reinforced concrete wind turbine foundations is much more complicated than one might expect at first sight. Reducing it to a 2D plate, as we see most designers do, over-simplifies the structure. Codes acknowledge these simplifications and introduce all kinds of design- and detailing rules to compensate the uncertainties, although one might debate the applicability of normal standards for this kind of structures.

Advanced modelling results in:

- A safer design, since we know what how the structure behaves.
- The possibility to optimize the reinforcement design and introduce reinforcement at the locations where it is effective. This is improving the business case for the project.
- Reduction of the use of resources and therefore a positive contribution to the environment.
- A simpler reinforcement layout that is easier and safer to execute and is less vulnerable for construction faults. As opposed to high rebar densities leading to congestion and possible quality and safety issues.



Nonlinear 3D design and the codes

An argument that we hear often is that (optimized) 3D designs are less safe because of the reduction of reinforcement. The codes are still respected by using safety factors that account for uncertainties in loads and material strengths. The Eurocode allows for the use of non-linear 3D models, however the individual rules in the code are based on a traditional design approach and are not always suitable to use for advanced models. We therefore sometimes need to make an interpretation of these rules to still honour the mechanisms behind these rules.

Validation and verification

Windbase has performed many verification exercises to confirm the validity of the models. By using simpler models, by doing lab test to verify material models, by verifying against scientific research and by doing full scale measurements. The fact that our foundations that we have designed and are built in the past are all functioning very well without any structural damage is also proof of good design. In all projects we incorporate internal review of validity of the model and the results in our processes. Independent of the design methodology, Windbase believes that a correct quality assurance and control is always needed.

Experience and acceptance

Non-linear models are inherently complex and require significant expertise to interpret. The results can be sensitive to various input parameters, which adds another layer of complexity to the design process. The long track record of Windbase obviously includes various discussions with reviewing parties with regards to the validity of our designs, since the engineering community tends to be conservative about adopting this kind of methodologies. Despite these discussions our designs were all accepted and built without major changes.



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