# Wind Turbine Foundation Analysis

**CIVIL** • ENVIRONMENTAL • MANUFACTURING • MINING • OIL & GAS • POWER GENERATION

## PROJECT DESCRIPTION

HDEC

Southeast Asia

FLAC3D™

In general, analysis performed on wind turbine foundations focus on the effects of the foundation's rotational stiffness and deformation for a range of overturning moments.

This project stage focused on the performance of the foundation and, given the local soil condition, its bearing capacity. To evaluate the behavior of the soil-structure interaction, a detailed numerical model of the concrete foundation and its steel reinforcement (i.e., rebar) was built and analyzed in *FLAC3D*.

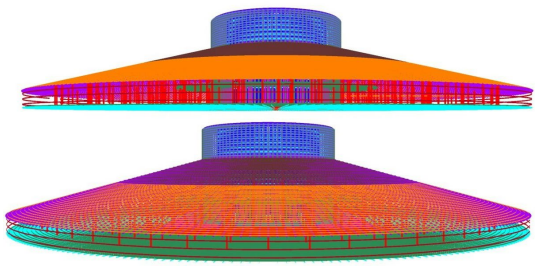

***Figure 1. Reinforcement layout.***

## ITASCA'S ROLE

For the numerical analyses, Itasca performed the following tasks:

- Interpreted the data from the geotechnical investigations.
- Estimated and calibrated appropriate constitutive models for the soil and foundation to capture the soil-structure interaction.
- Modeled the steel reinforcement as an elastoplastic material, where the connection between rebar and concrete was simulated via links that considered the adhesion between the concrete and steel.
- Evaluated the performance and failure mechanisms by simulating an overturning moment load test on the foundation until failure was observed.

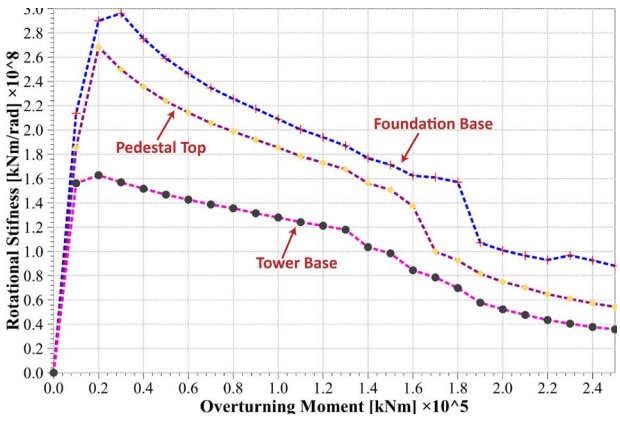


***Figure 2. Rotational stiffness: applied moment/rotation.***

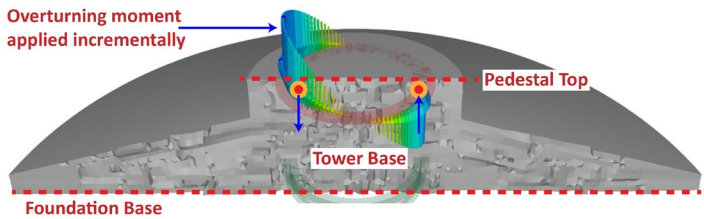


***Figure 3. Overturning moment numerical load test.***

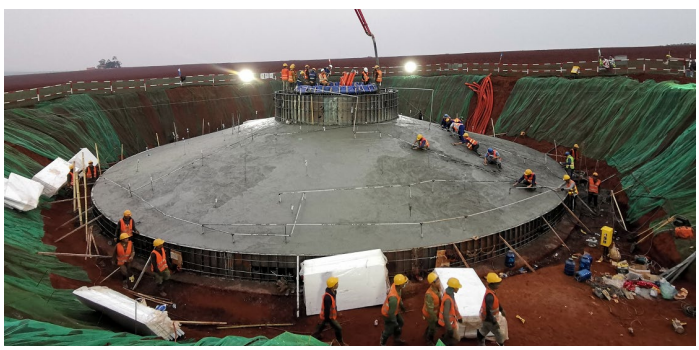

***Figure 4. Foundation construction.***


Itasca Consulting Group, Inc.
111 3rd Avenue South, Suite 450
Minneapolis, MN, USA 55401 | +1 (612) 371-4711 | info@itascacg.com

www.itascainternational.com
www.itascacg.com


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## PROJECT RESULTS

Using *FLAC3D*, Itasca was able to analyze the performance and failure mechanisms of the system. The results show the following:

- The performance requirements are satisfied.
- The failure mechanism starts in the structure.
- The high stresses in the concrete develop localized deformations, which significantly reduces the stiffness of the system.
- Rebar was predicted to yield in the circumferential direction in the upper and lower part of the foundation, but no rebar element reached the strain limit and the stress mobilized was acceptable.
- Given the results, Itasca proposed a conical foundation design.

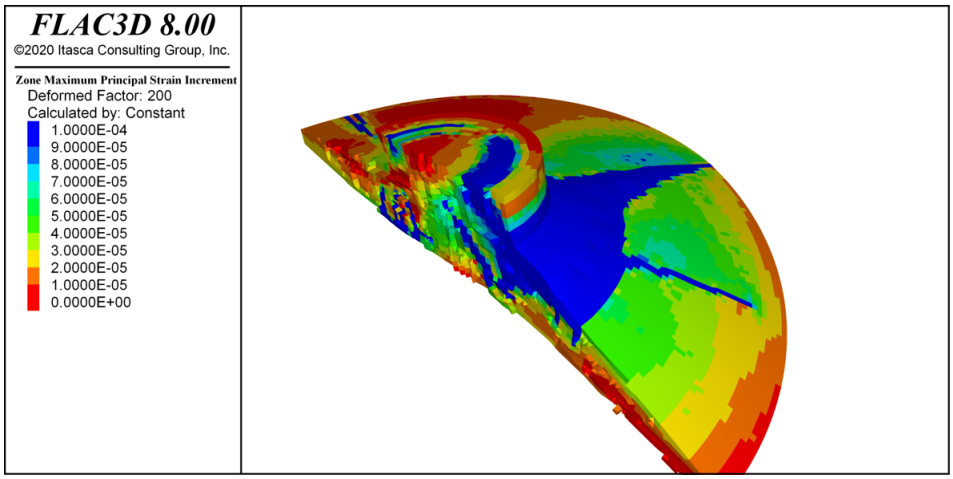


***Figure 5. Cracking in the foundation propagates radially and circumferentially.***

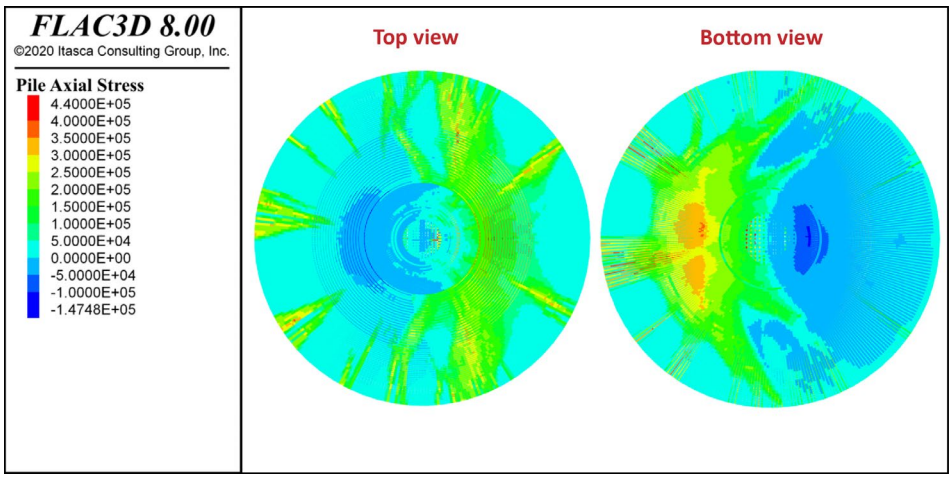


***Figure 6. Axial stress mobilized in the foundation steel.***



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