Thesis Title: "Bearing Capacity of Wind Turbine Circular Foundations under Multi-Directional Loads in Clay: Abaqus-Based Torsional Reduction Factor."

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A closer look at how shallow supports behave beneath wind turbines reveals complex interactions between the ground and the structure when forces push down, push sideways, twist, or tilt. Although older methods handle off-center or angled pushes fairly well, twisting actions are rarely treated properly - neither in official rules nor scholarly work. Rules like those from DNV/Risø account for shifted load centers by shrinking the usable base area, yet omit any practical way to account for uneven stresses caused by rotation. Ignoring this might make some big turbine bases appear stronger than they truly are. To fill that hole, this study builds a logical upgrade to classic strength models, grounded in physical behavior, that targets how twist affects round footings sitting on soft clay.

Starting with Meyerhof's 1953 research, then folding in Highter and Anders' 1985 ideas on usable base area, along with DNV/Risø standards for turbine supports, the analysis takes shape. Instead of calling it just 'offset,' the uneven pressure distribution is mathematically pinned down by dividing the total tilt effect by the downward push, matching how forces balance in real conditions. When a twisting force acts on the base, pressure beneath shifts to the side, creating an imbalance even if nothing is tipping over the usual way. Because of this shift, treating twist like an off-center load makes sense: take the turning effort, divide by the weight pressing down, and get a pretend offset value. That number slots right into older models meant for lopsided loads.

To examine how circular foundations respond, Abaqus simulations explore the effects of mixed vertical and lateral forces, along with twisting and bending. Instead of even pressure patterns, calculations show uneven stress zones, higher maximum pressures, and only some parts of the base fully resisting load when twist is involved. Because of these changes, the working area shrinks more than what standard off-center load models suggest. By examining detailed pressure maps, researchers adjust traditional area estimates using a new correction tied to twisting force levels. This adjustment depends on relative torsional strength and is based on simulation data under firm clay conditions.

A real-world case, based on extensive wind turbine supports, shows how three methods stack up when calculating bearing capacity one by Highter and Anders, another from DNV/Risø, plus a new version adjusted for twisting forces. Outcomes reveal that omitting twist effects can inflate maximum load estimates by 5-25% under typical conditions, whereas the updated approach offers a safer, physics-aligned fix. Though tweaked, the model still fits current workflows without demanding extra data, so it works well during early or mid-phase planning.

When designing shallow foundations for wind turbines, twisting forces require careful attention - especially if the spinning parts generate strong lateral forces. Twisting loads matter most where rotation causes uneven stress below ground level. A new way to calculate safety builds on old ideas about soil strength but uses solid physics rather than guesswork. This method closely follows real material behavior and is carefully checked against computer models. It skips shaky rules pulled from past projects without proof. Engineers get guidance on how to apply it now in their daily work. Ideas also point toward testing the method in layered earth types later. Long-term performance under repeated loads remains an open area for exploration. Future studies could adapt the framework for more complex ground setups.