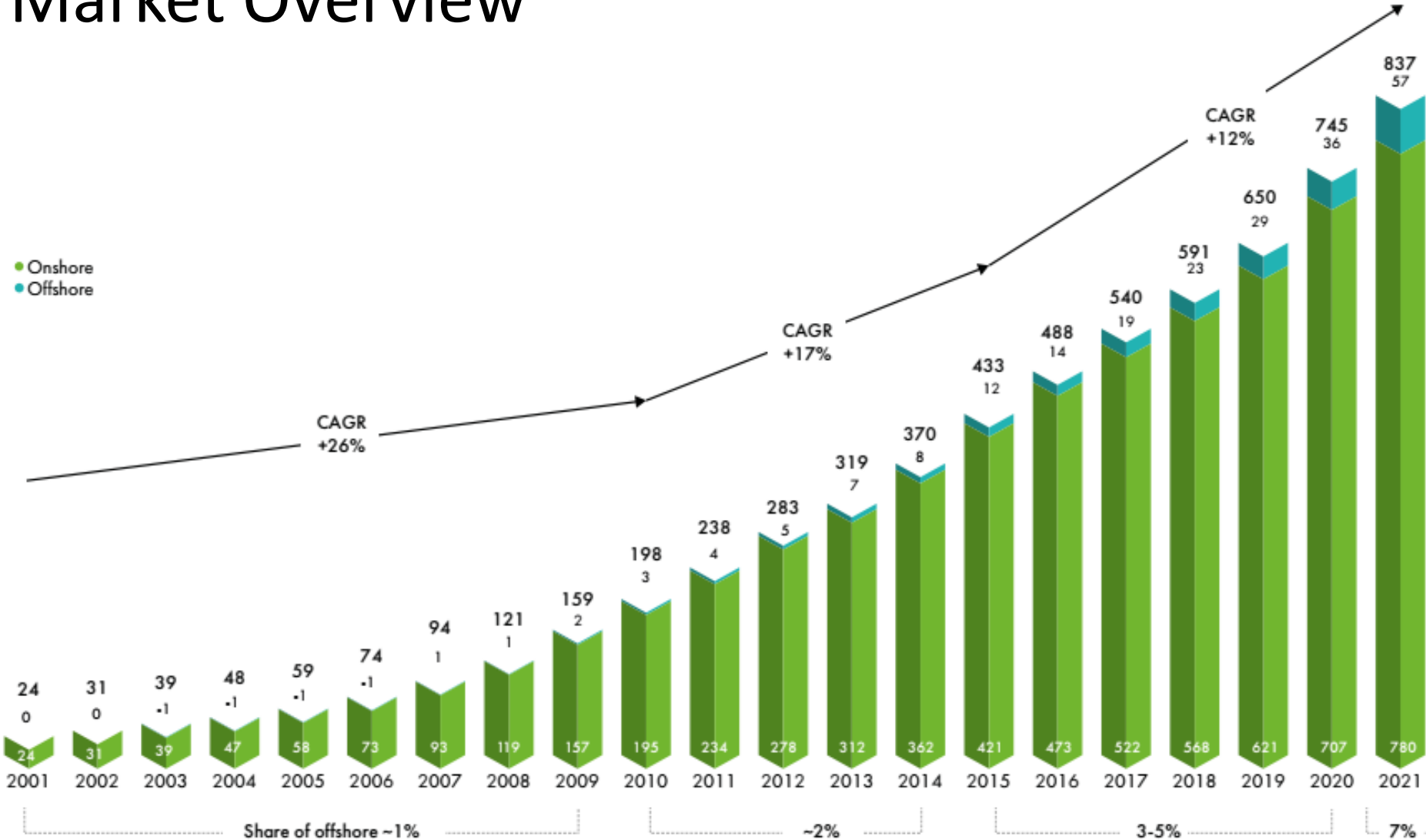


# The Hidden Opportunity: Can micropiles reduce cost and carbon in the windpower sector.



# Market Overview

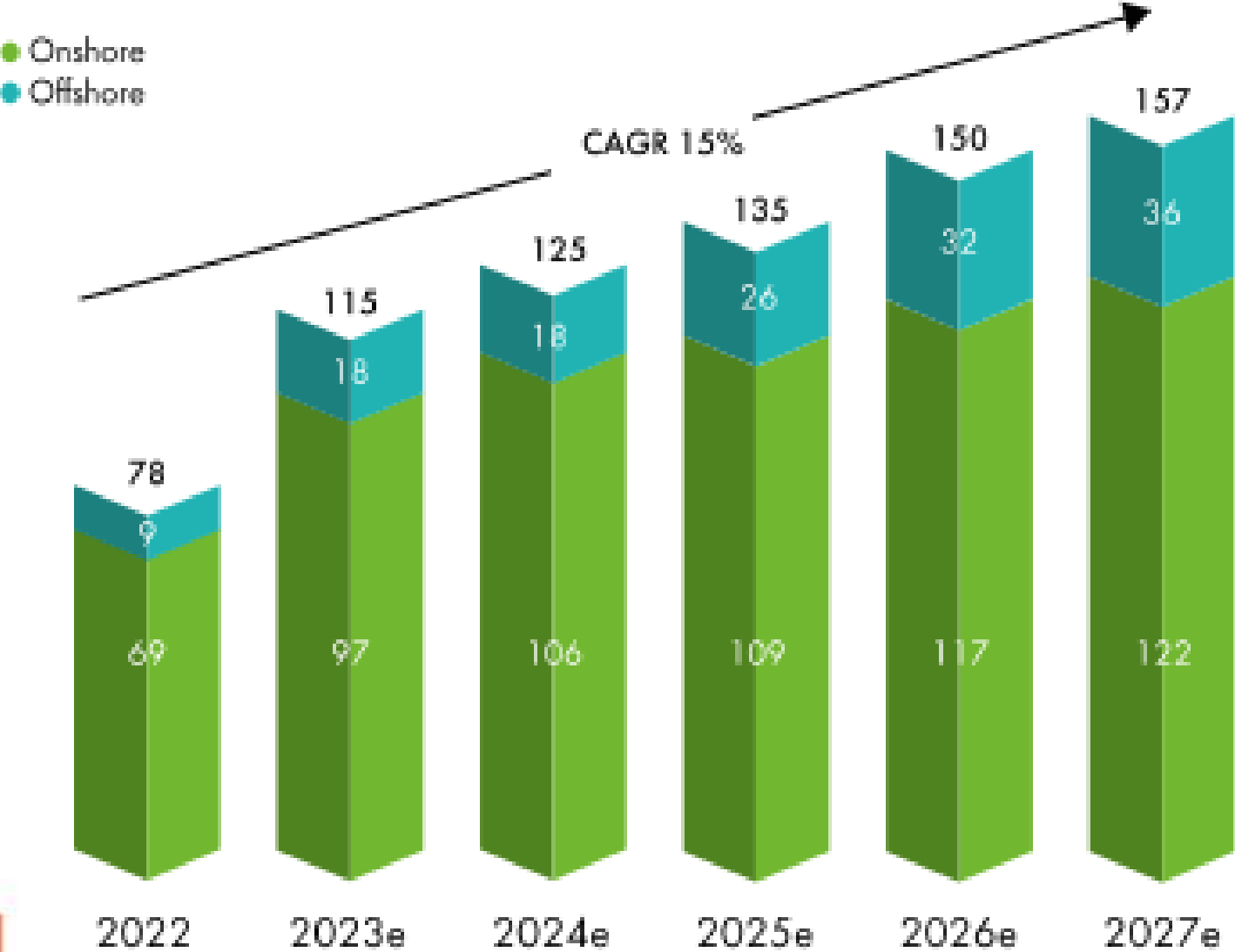
- Onshore
- Offshore



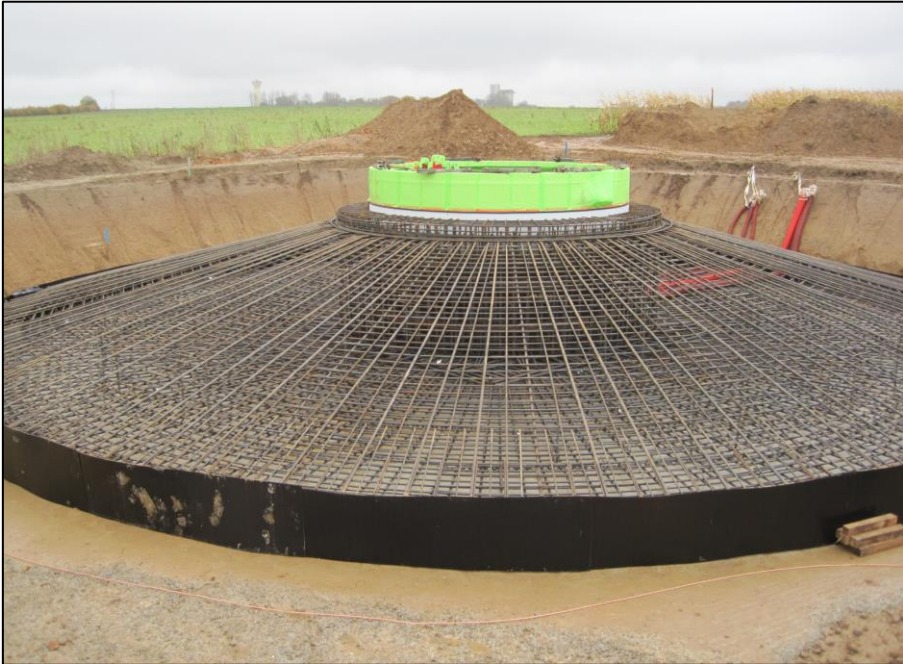
Source GWEC Global Wind Report 2022.

# Market Overview

New installations outlook 2022-2026 (GW)



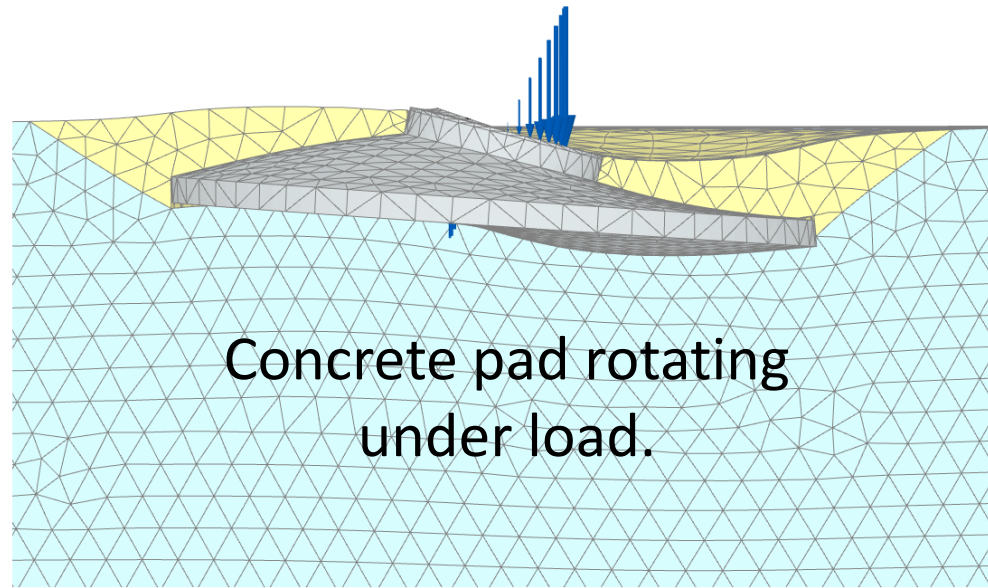
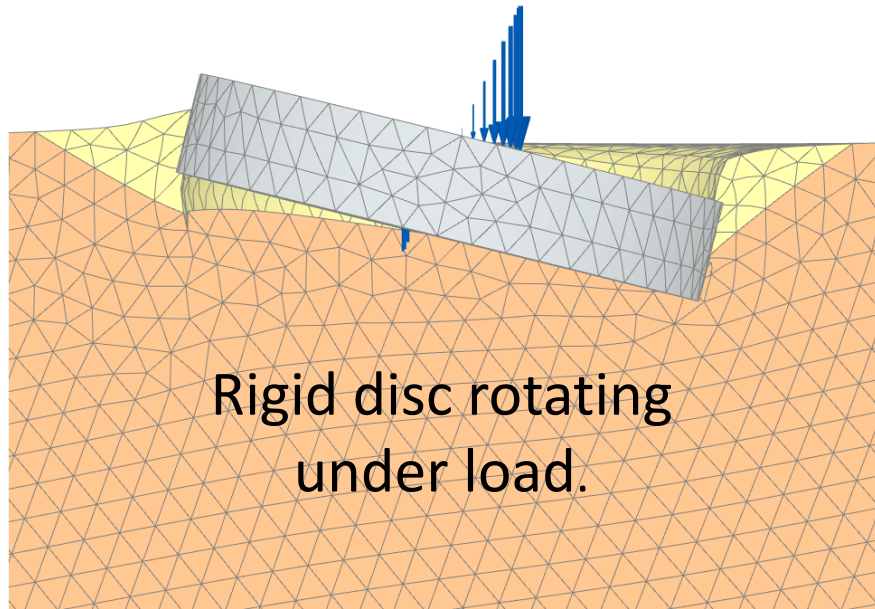
# Wind Turbine Foundations: Status Quo.



Mass Gravity Concrete Pads

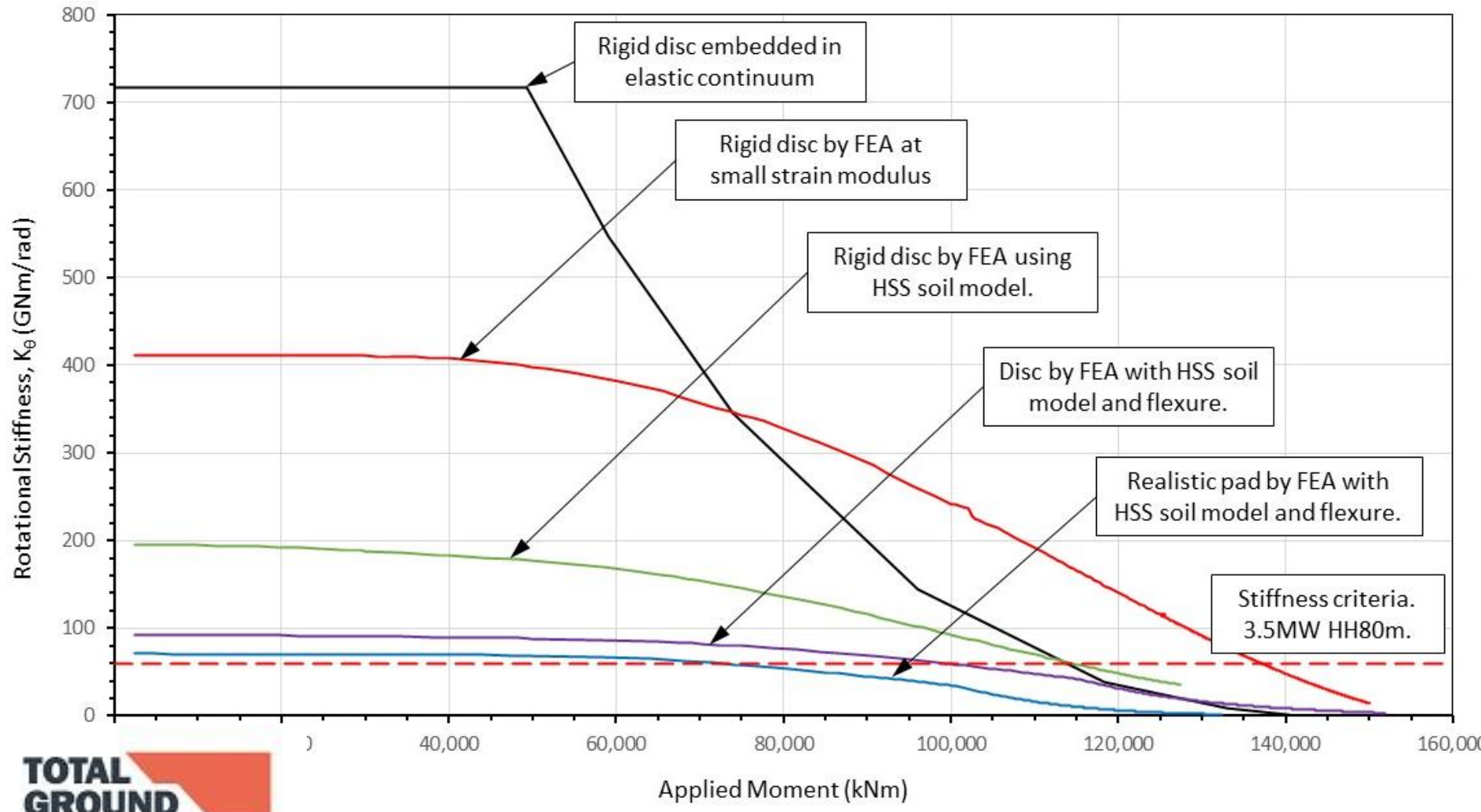


# Gravity Pad Foundations: Rotational Stiffness



# Gravity Pad Foundations: Analysis of Rotational Stiffness

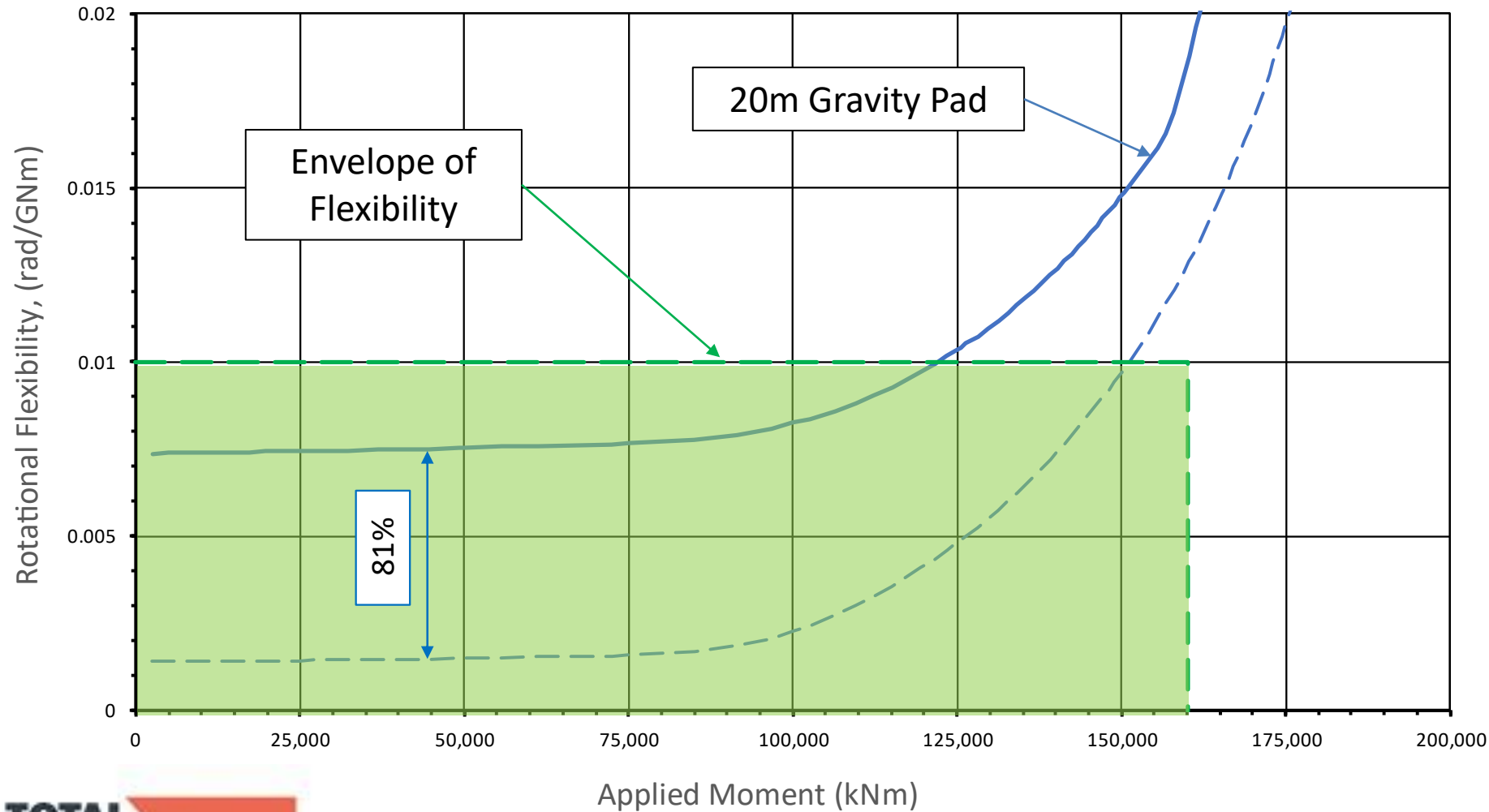
16m Diameter pad. Progression of analyses from rudimentary to more complex and realistic.



# Gravity Pad Foundations:

## Quantifying Flexure 1

Rotational Flexibility

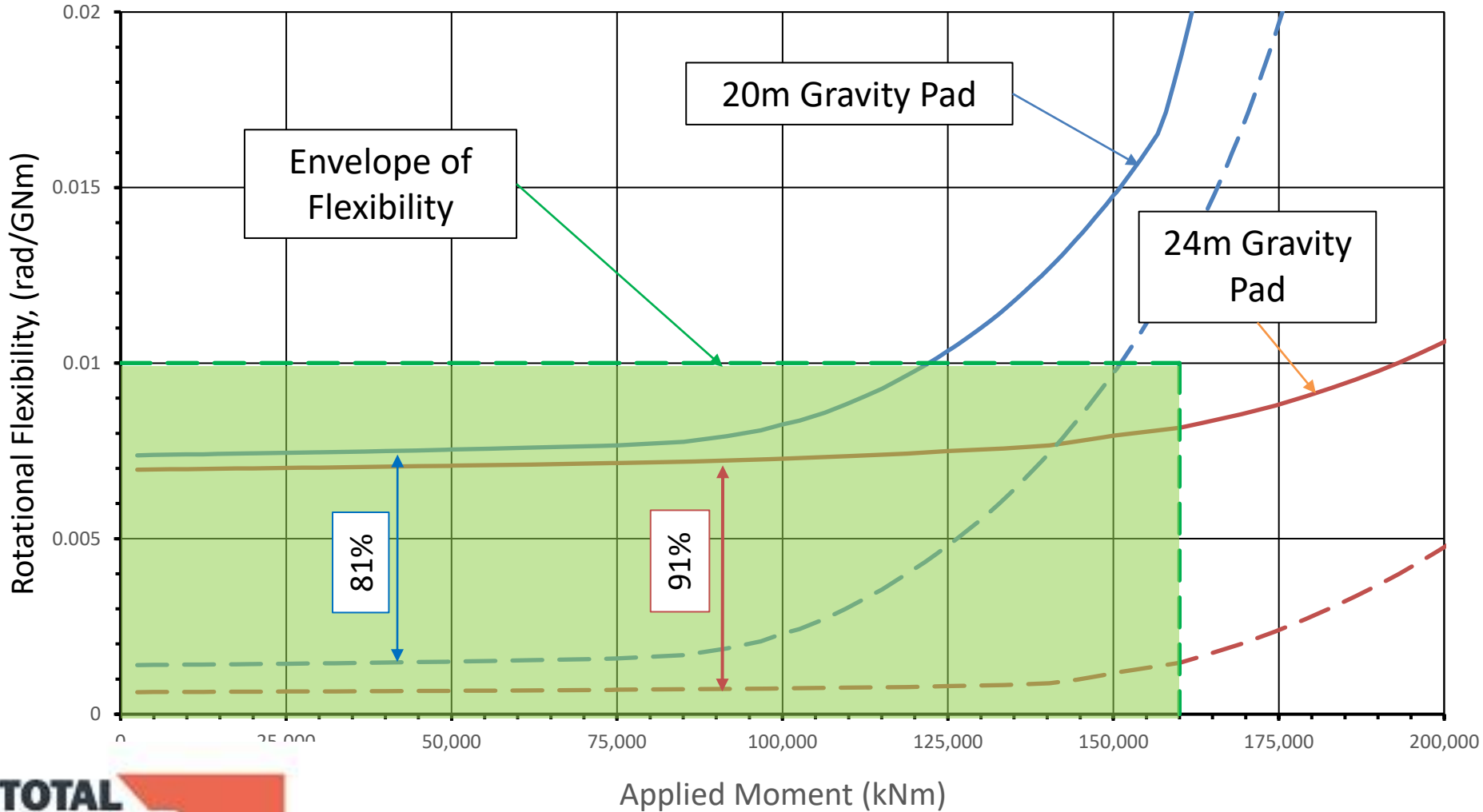


— Base/soil

— Design Requirements

# Gravity Pad Foundations: Quantifying Flexure 2

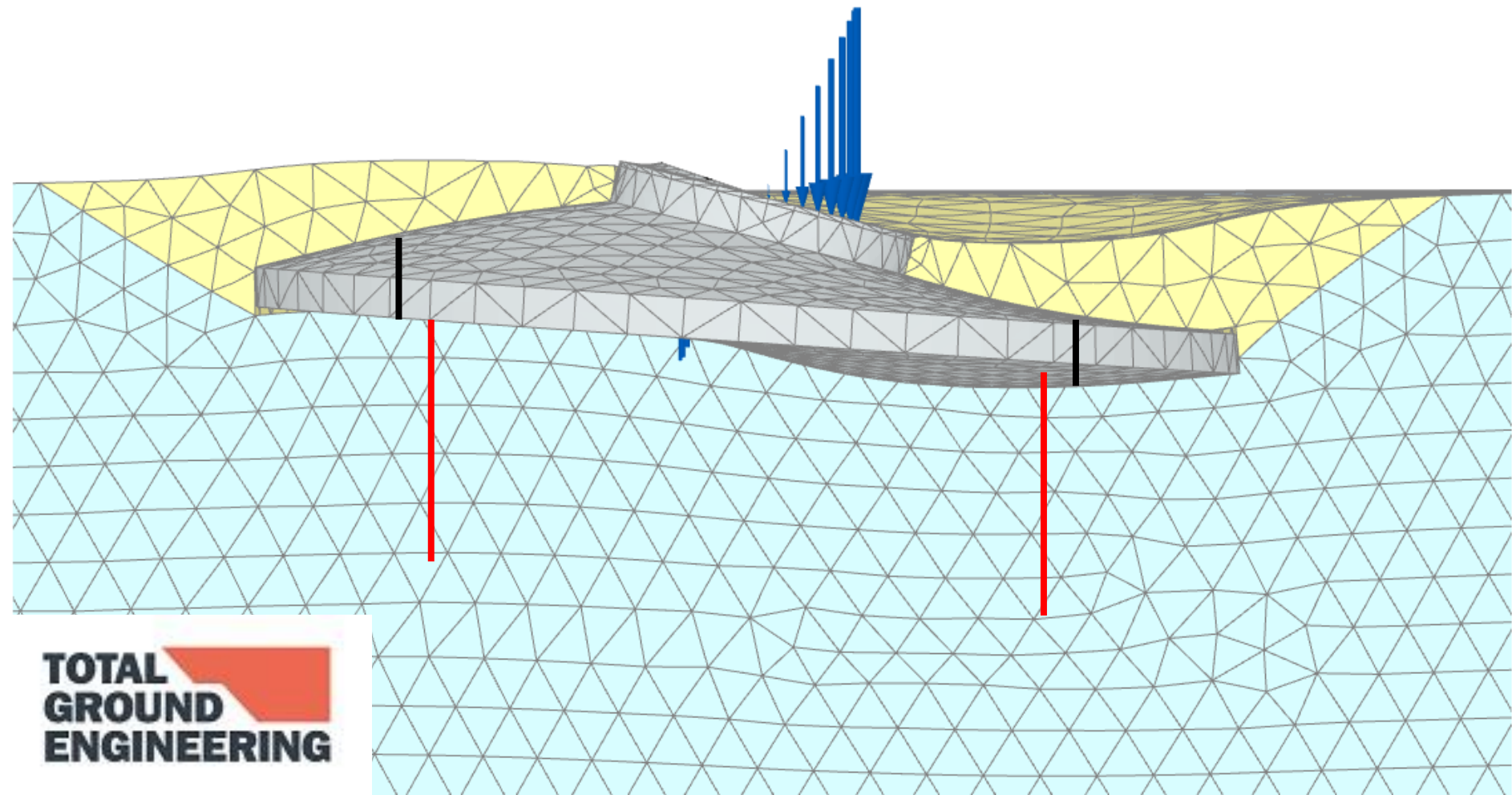
## Rotational Flexibility





# Micropile Foundations:

## Conceptual benefits of a pile group



# Micropile Foundations: Limitations on Pile Design

**DNV GL Guidelines cl 7.6.3.3**

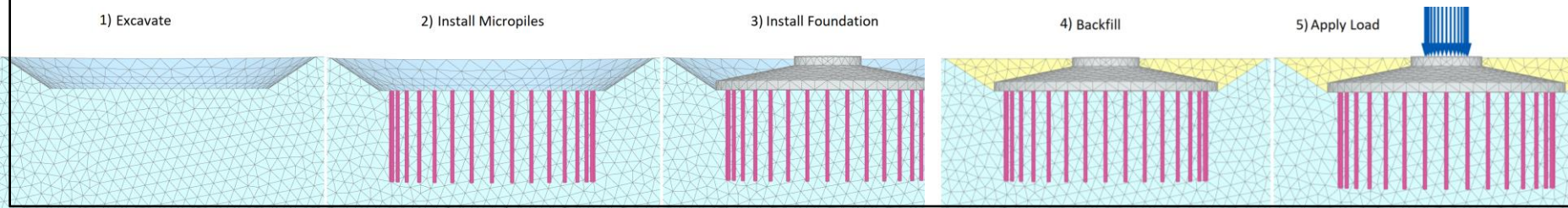
**International Energy Commission  
EIC61400-6 Guidelines, cl 8.6.4.4**

**Vestas Design Specification. Cl 5.1.1**

# Micropile foundations:

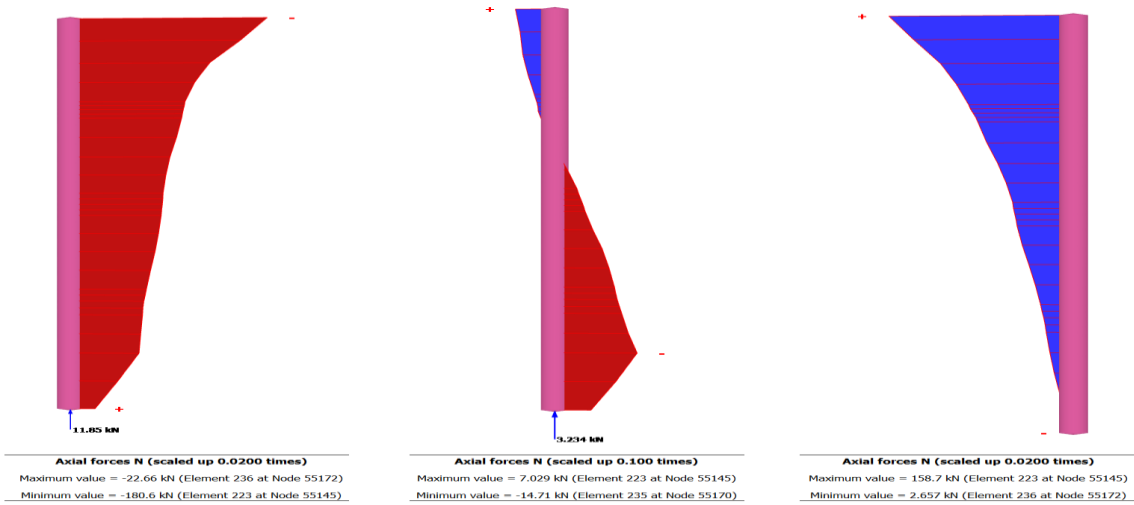
## Robust FEA

Accurate modelling of construction phases.



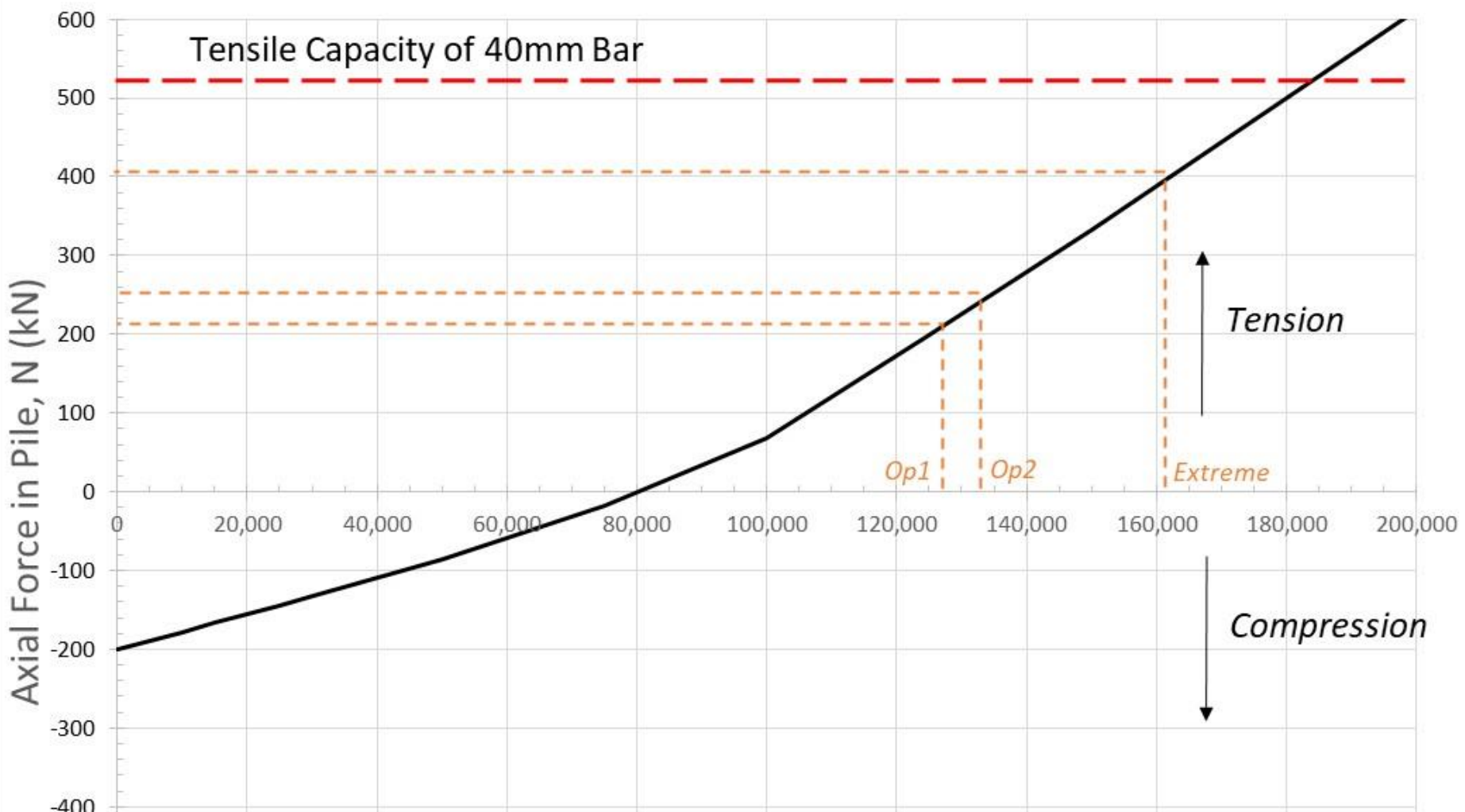
### Progression of tensile stresses in the piles.

Increasing Overturning Moment

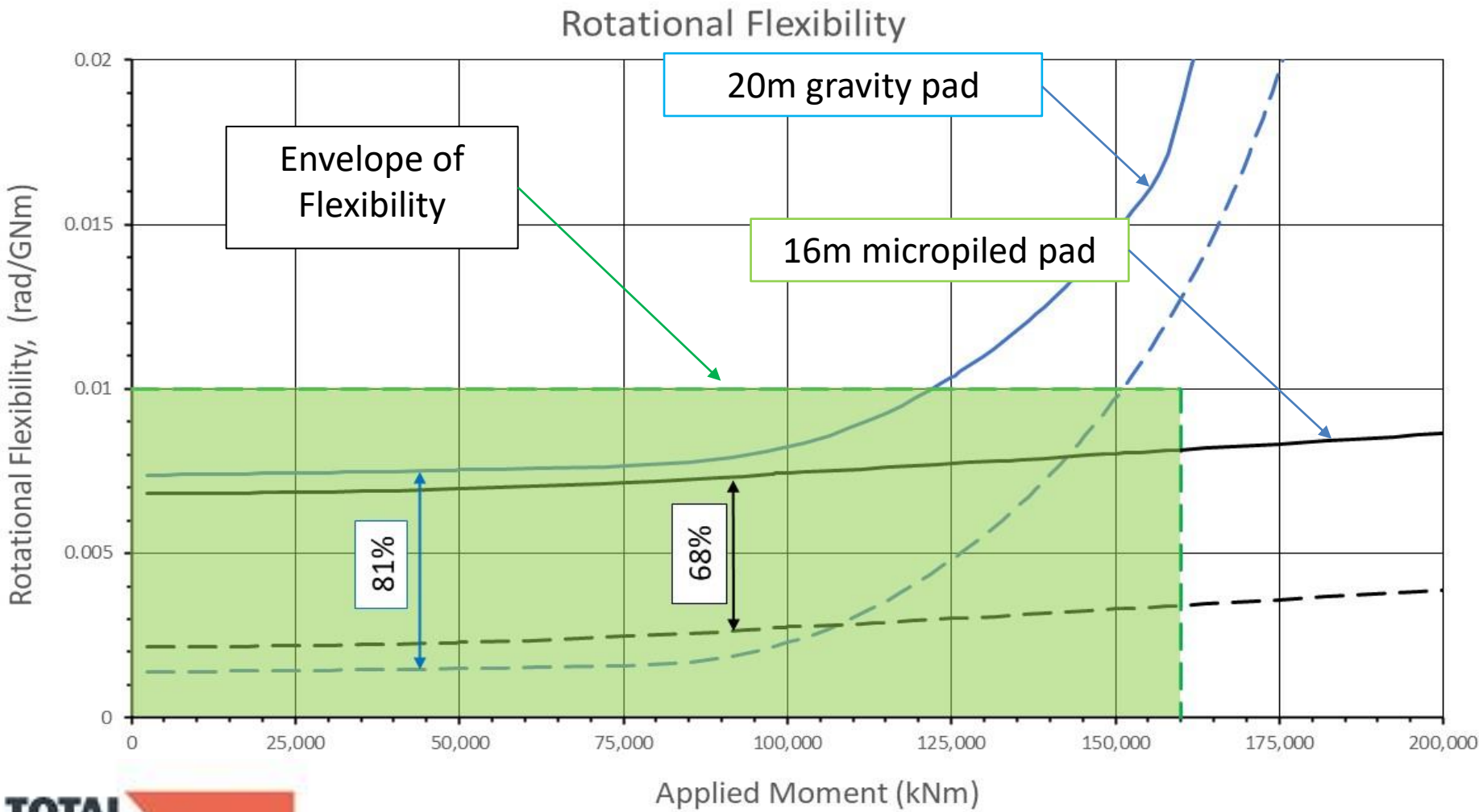


# Micropile foundations: Delayed onset of tension

## Onset of Tension in Piles

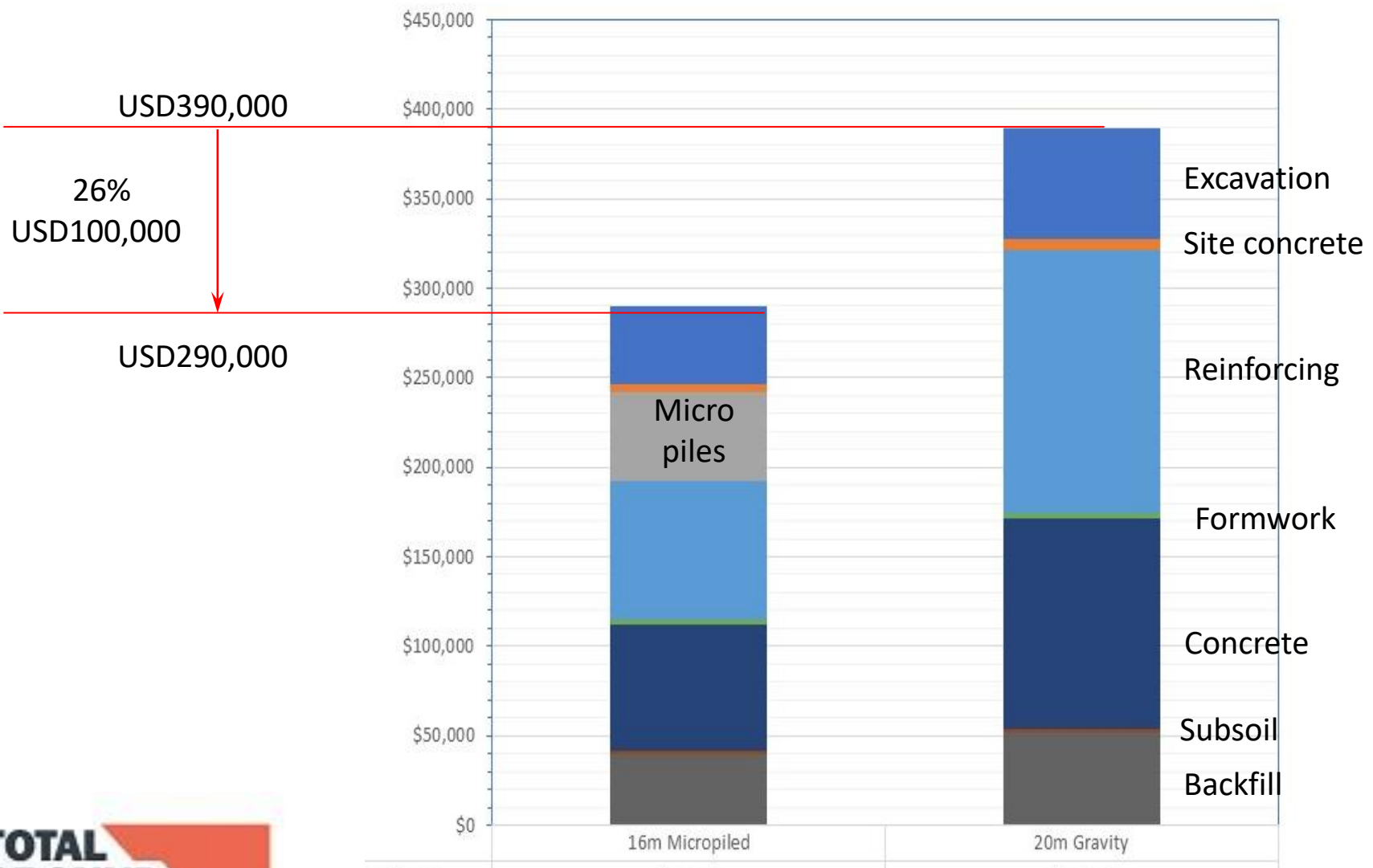


# Micropile v Gravity Foundations: Quantifying Flexure





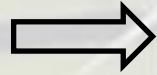
# Micropile v Gravity Foundations: Cost Comparison



# Market Overview Revisited:

## Value Proposition

6,300 turbines  
installed per  
annum by 2027.



x \$390,000 per  
gravity pad  
= CAPEX of  
\$2,500,000,000.



-26% (\$100,000 per  
micropiled pad)  
= Saving of  
\$630,000,000.

# Market Opportunity

6,300 turbines installed  
per annum by 2027.



26% of 2,500,000,000  
= Saving of \$630,000,000.

16 to 24 micropiles at 26ft each  
= 2,600,000ft to 3,900,000ft of micropiles