Cross-Calibrated In-Situ Shear Strength of Gold Tailings

from CPTu, Vane Shear, and NorSand Modeling

Knight Piésold CONSULTING

Going further together

Outline

The Problem

Study Overview

Field Application

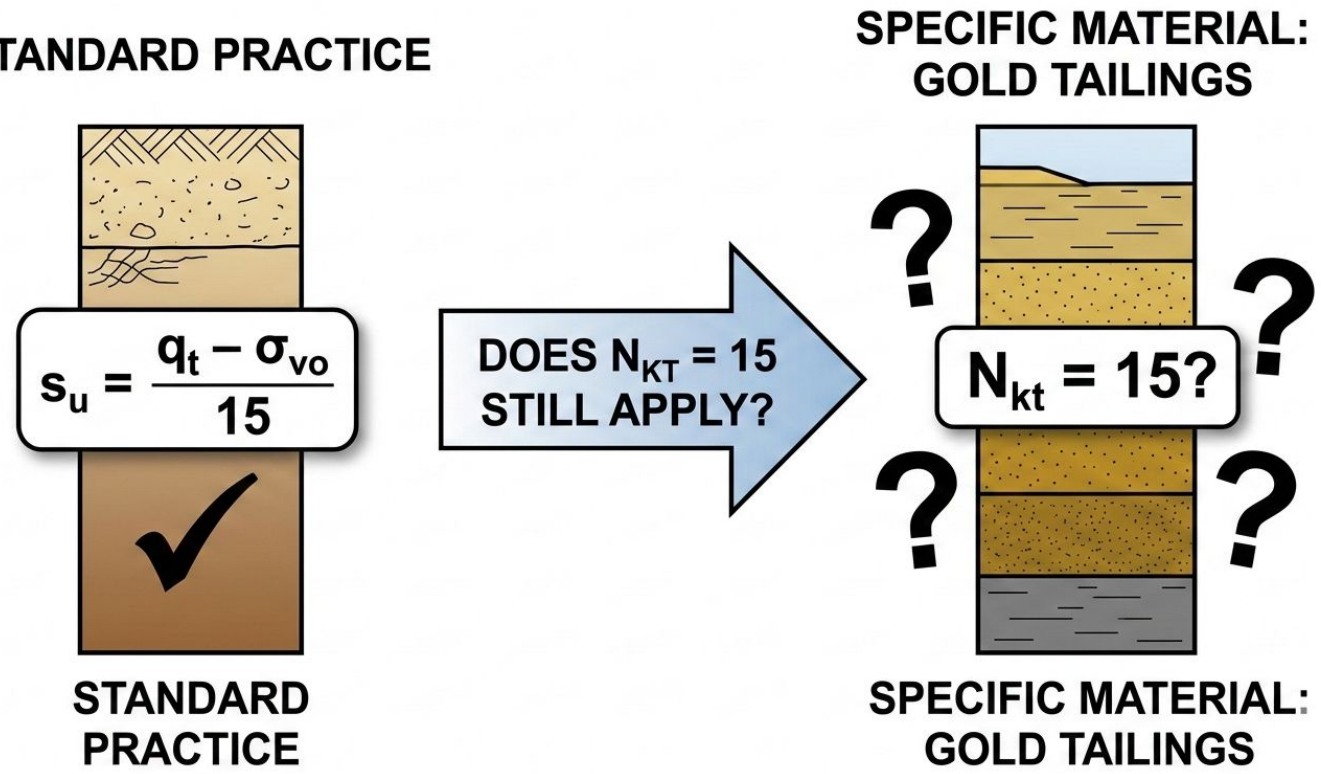
The Problem

Traditional Approach

CPT-Su Uncertainty

Nkt = 15 (default)

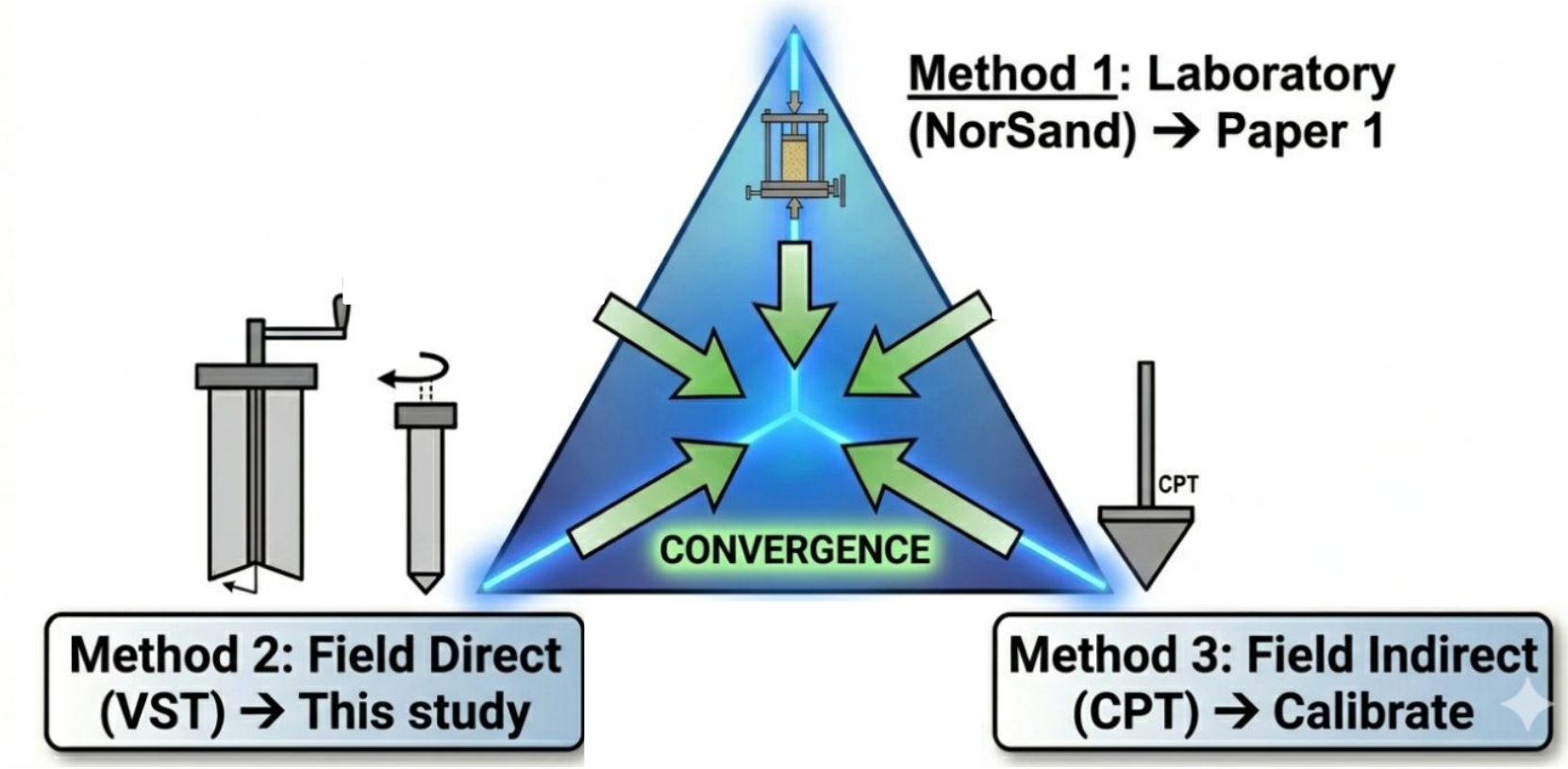
- But is this correct for gold tailings?
- How do we validate CPT-derived strengths?
- What if default Nkt is wrong?



The Solution - Triangulation

Tri-Method Validation

- Method 1: Laboratory
  - (NorSand)
- Method 2: Field
  - Vane Shear Testing
- Method 3: Field
  - CPT Testing



Study Overview

Study Overview

Investigation Scope

- Gold TSF, South Africa
- **31 Vane Shear Test (VST)**
- 36 CPT Positions
- 8 cross-sections
- Max height: 50 m

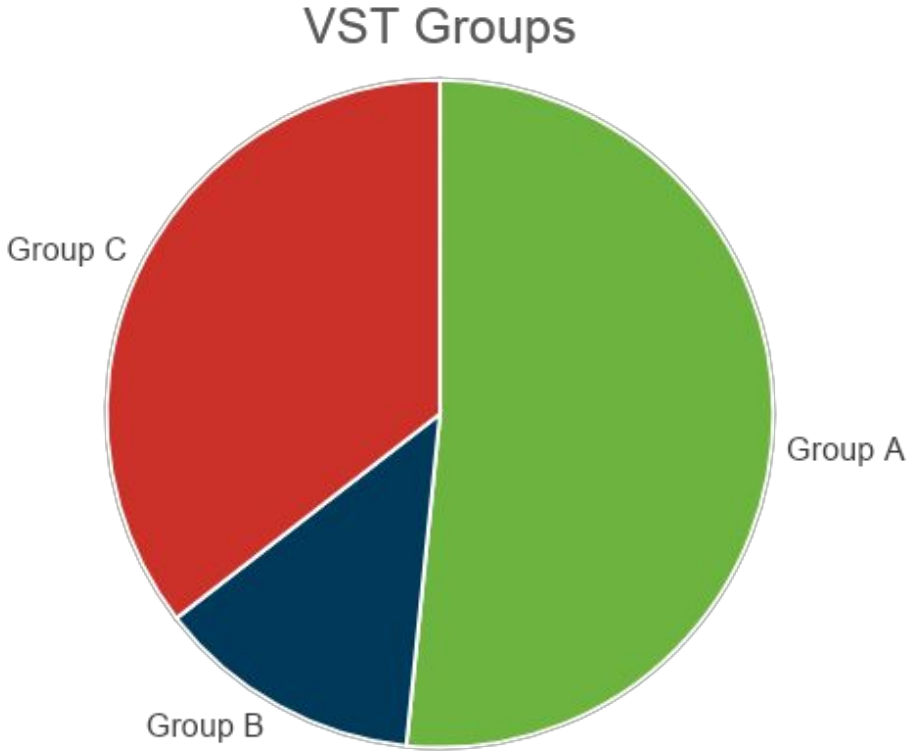
VST Equipment & Challenge

Vane Shear Testing

- Equipment: AP van den Berg, 40×100mm, 4-blade

Quality Grouping

- Group A: Reliable, undrained (n=16)
  - T < 0.02, no blade damage
  - USED FOR CALIBRATION
- Group B: Blade damage (n=4)
  - Excluded
- Group C: Refused/drained (n=11)
  - Excluded



Back-Calculation Process

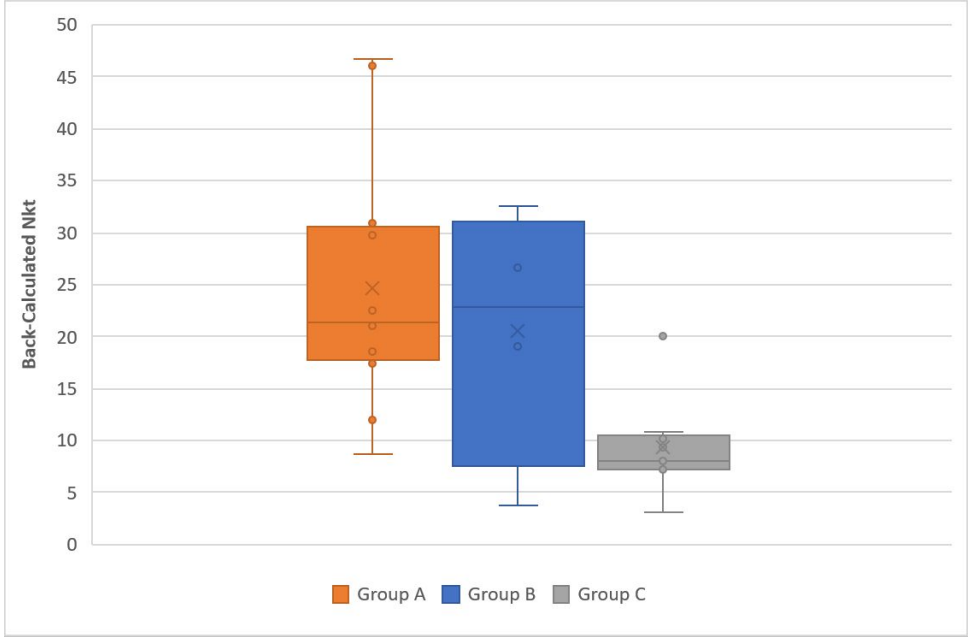
Nkt Back-Calculation

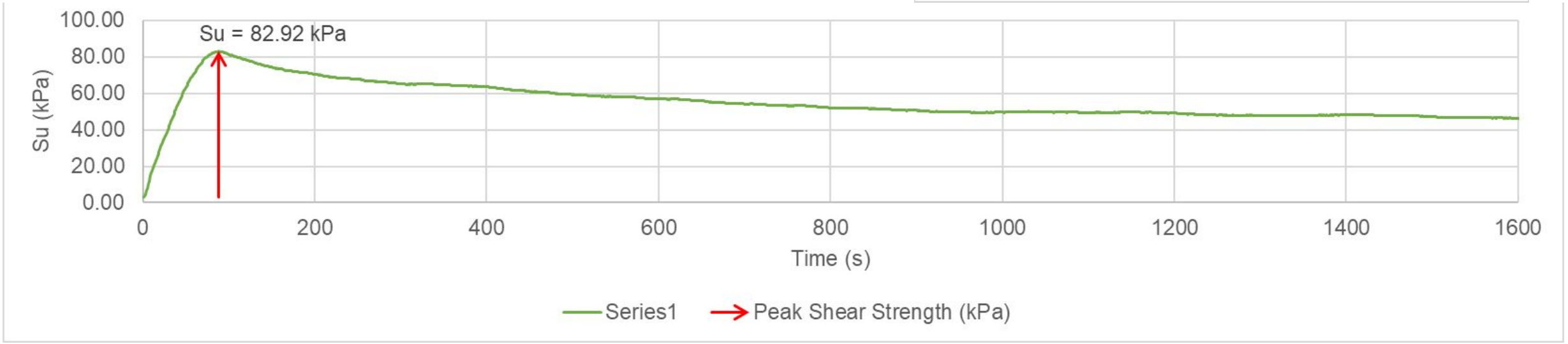
At each VST depth:

- Nkt = (qt - σv) / Su(VST)

16 VST locations → 16 Nkt values

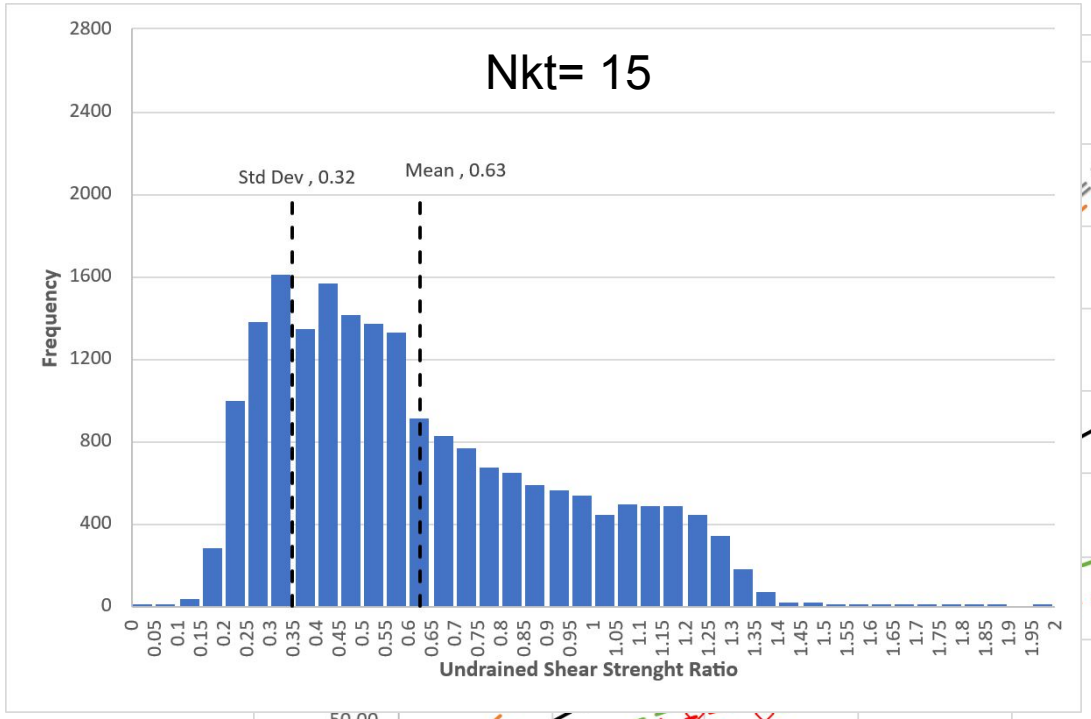
- Range: 8.8 to 215.9 (huge variability!)

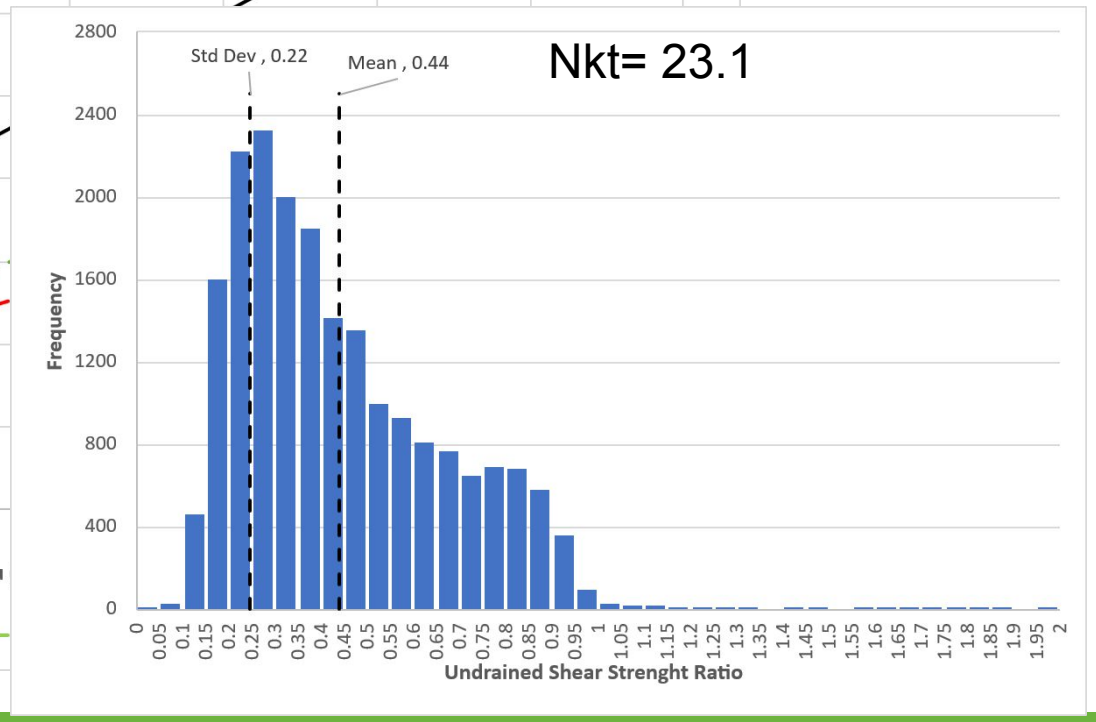




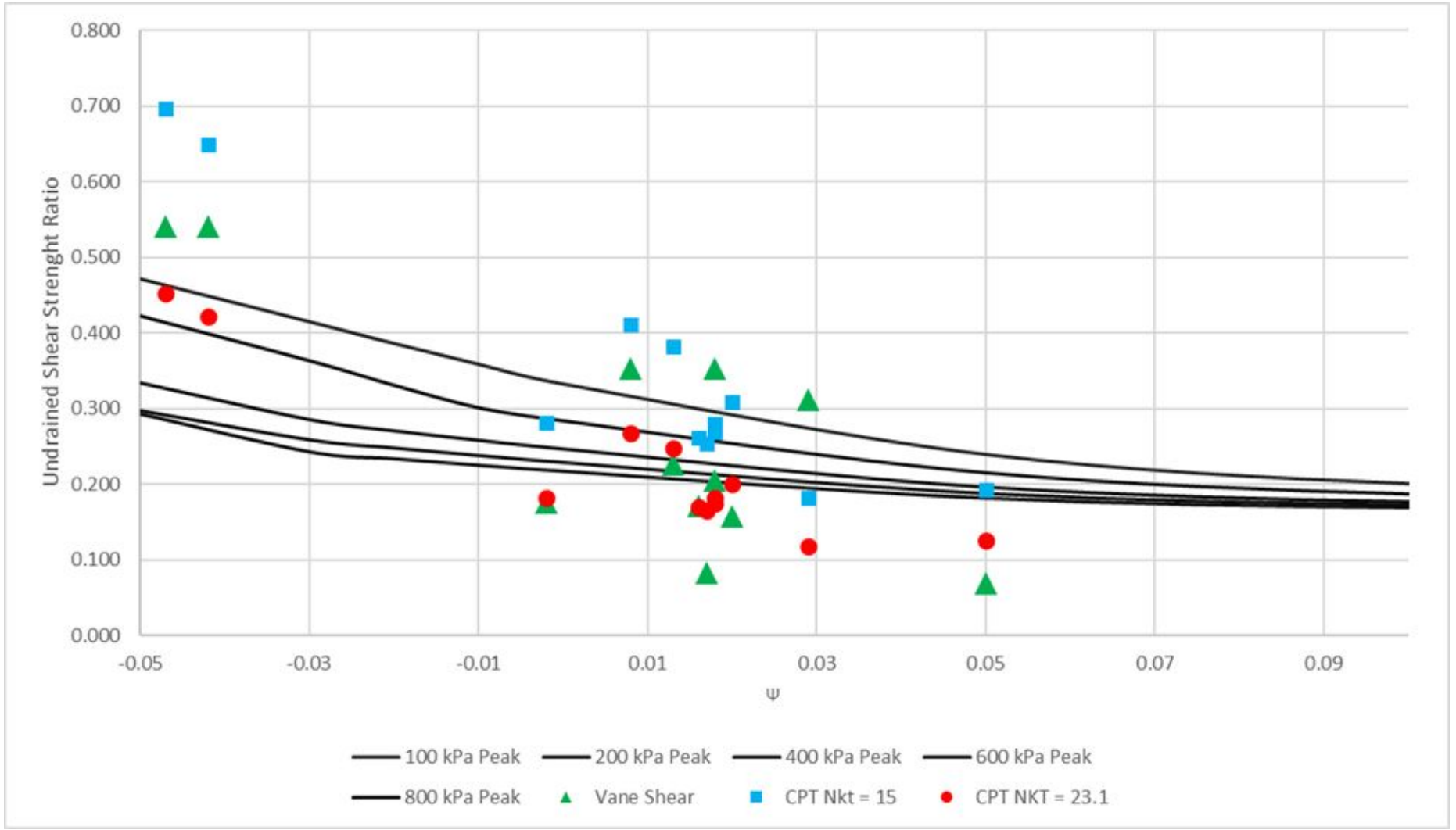
Regression Calibration

Calibrated Nkt From Regression





THE TRIANGULATION



The Convergence

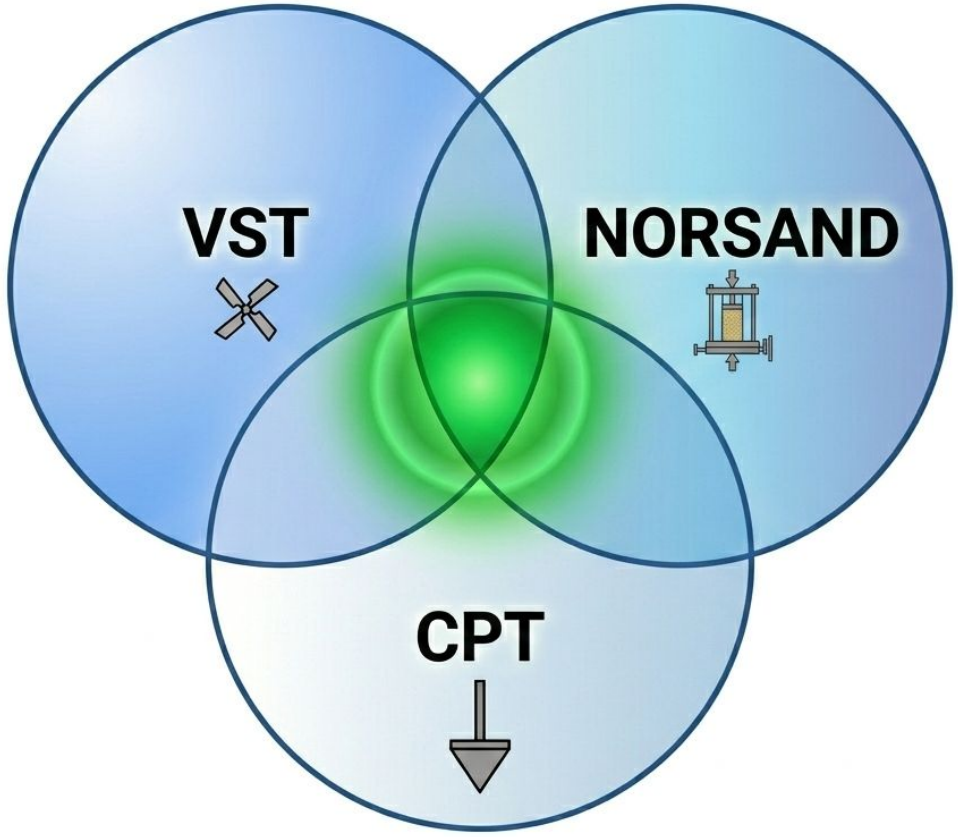
All Three Methods

	n	Average Su/p'	Deviation from Triangulated Mean
VST (Group A)	10	0.27	+8%
CPT (Nkt = 23.1, calibrated)	10	0.24	-4%
NorSand Envelope (200-800 kPa)	-	0.25	0%
Triangulated Average		**0.25**	**±12%**
CPT (Nkt = 15, default)	10	0.37	+48%

Key Findings

- NorSand: Lab-based, theory
- VST: Direct field measurement
- CPT: Continuous profiling

- All independent, all converge
- CONFIDENCE the answer is correct!



Practical Workflow

Recommended Approach

1. VST at representative depths
2. Quality screening ($T < 0.02$)
3. Back-calculate Nkt
4. Statistical screening (outliers)
5. Regression calibration
6. Validate with NorSand (if available)

Conclusions

Site-specific Nkt = 23.1 validated through:

- VST measurements (Su/p' = 0.27)
- CPT calibration (Su/p' = 0.24)
- NorSand modeling (Su/p' = 0.25)

- Tri-method convergence within 12%
- Default Nkt = 15 overestimates by 48%
- Rigorous VST quality screening essential
  - 52% exclusion rate in tailings
- Multi-method validation provides confidence

Q&A

Juan Swanepoel
+27 79 069 4319
jswanepoel@knightpiesold.com