The 24th World Dredging Congress & Exposition

WODCON XXIV

"Dredging Towards a More Resilient Future"

Hosted by WEDA

WEDA
Western Dredging Association

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The Cutting of Clay:
Different Methods to Predict Clogging the Cutter Head

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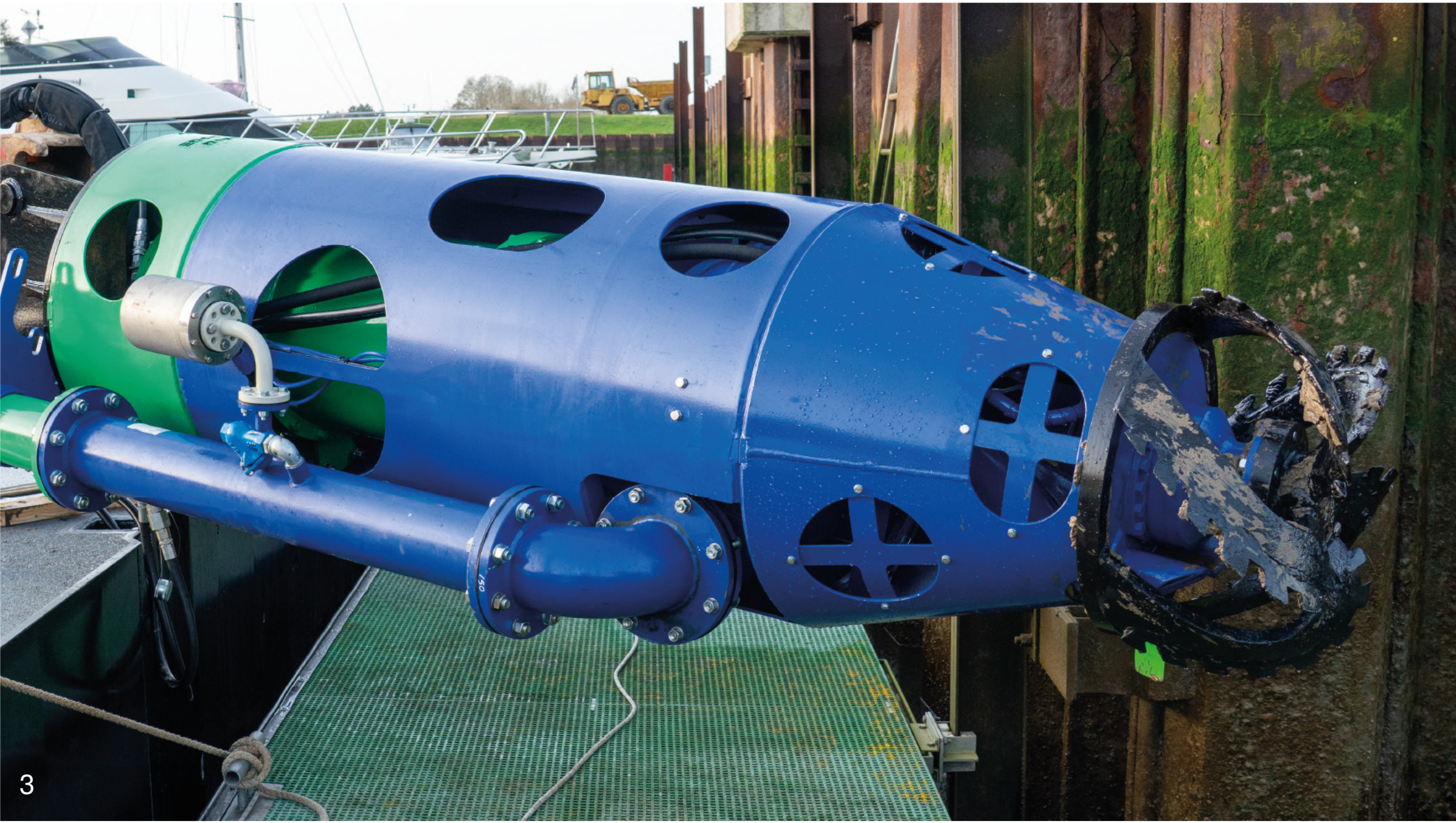

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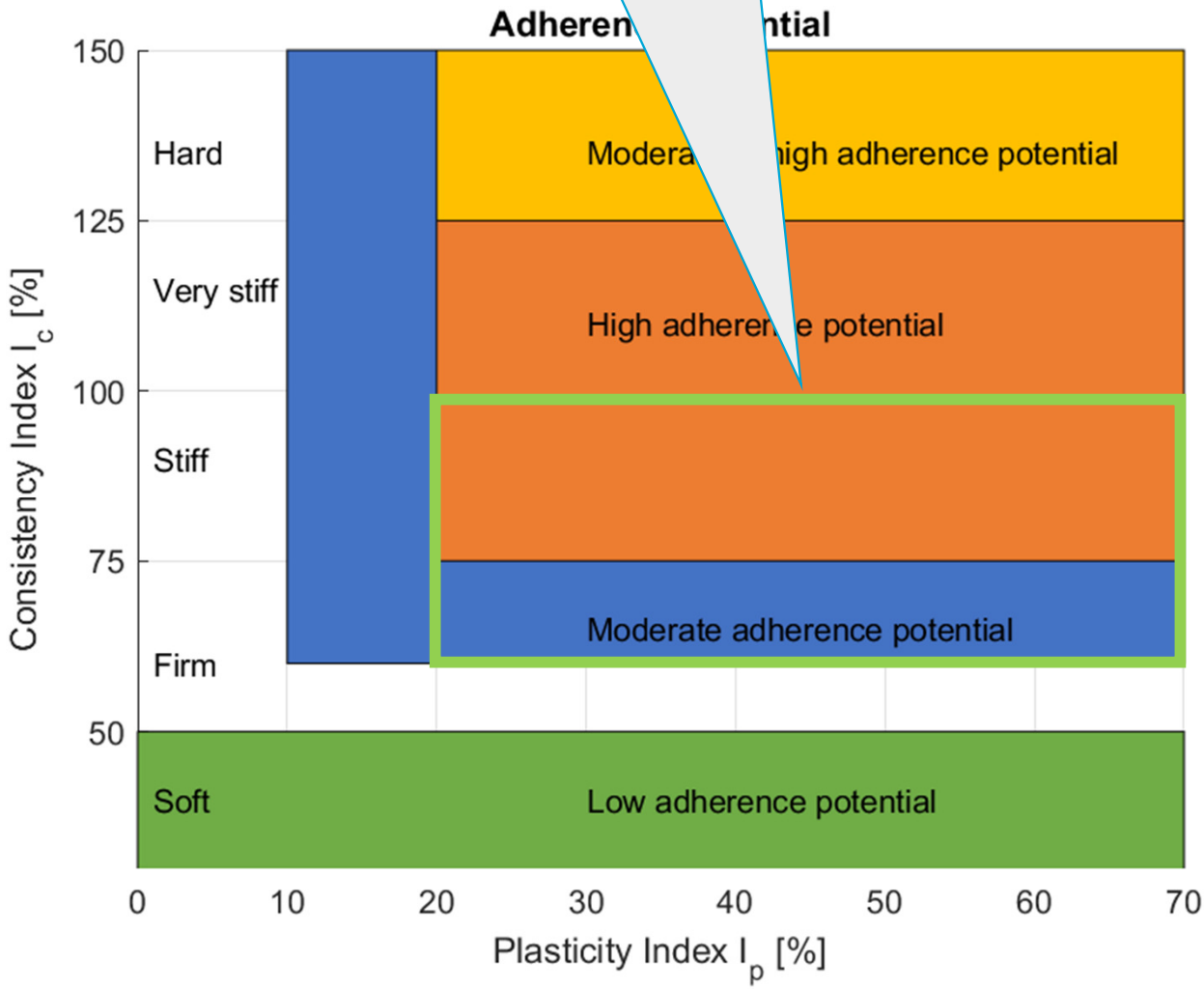
Adherence Potential Recommendation

- Recommended by PIANC[1]
- Supported by CEDA[2]/IADC[3]
- PI: mineral dependent
- CI: local condition
- Static soil conditions

CROW[4] Recommendation for clay application in infrastructure projects



1. World Association for Waterborne Transport Infrastructure
2. Central Dredging Association
3. International Association of Dredging Companies
4. Center for Legislation in Infrastructure

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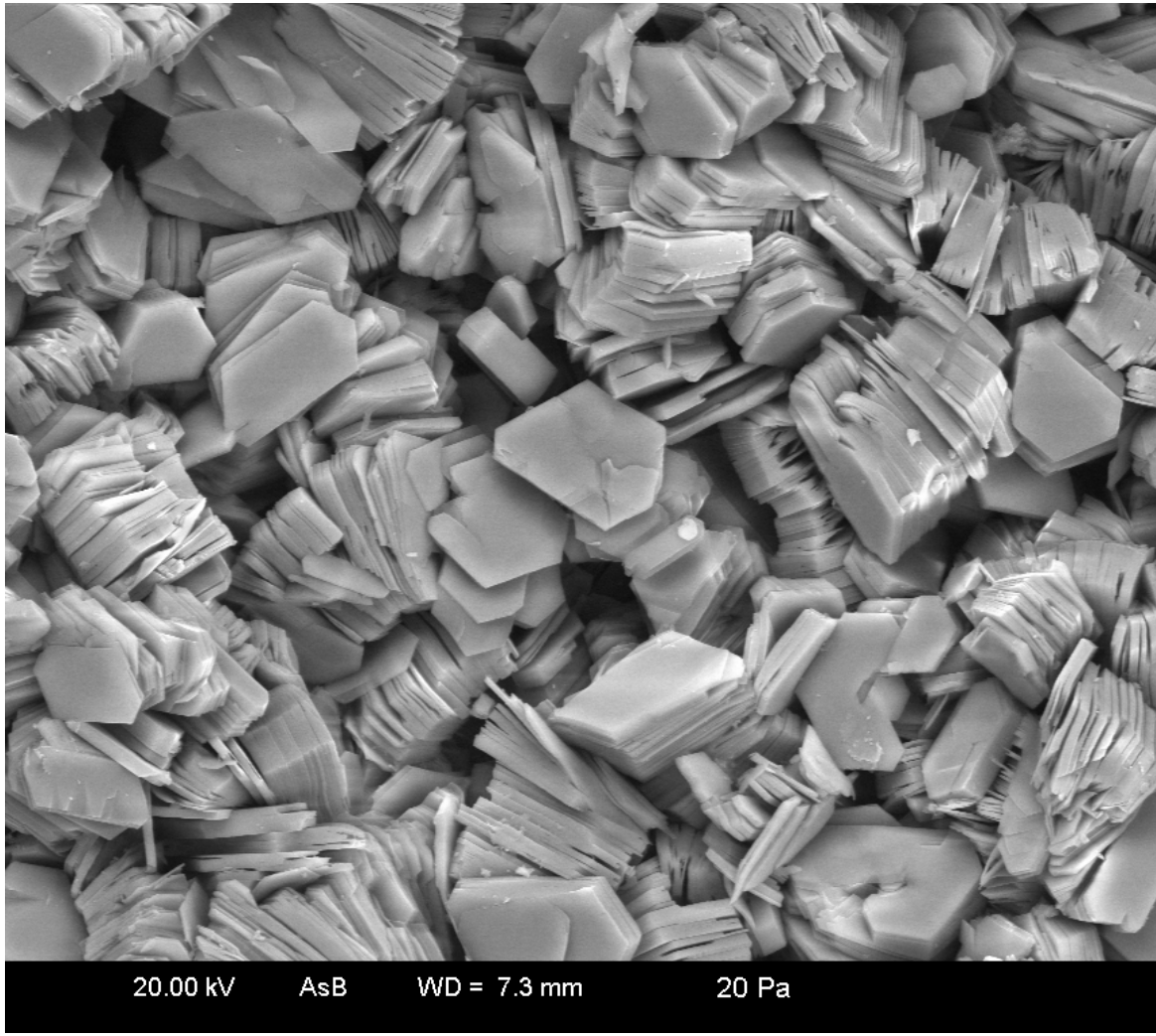
Research Questions on the Adherence Potential

- Why is adherence potential not always accurate?
- Are there other estimations?
- Any other recommendations?
- Applicable for the dredging industry?

Clay minerals: chemical and physical properties

- Hexagonal discs
- Very small ~2nm (Mesh 7000)
- Charge distribution
- Stacks of discs
- Plasticity
- Good water absorption
- Adherence to surfaces



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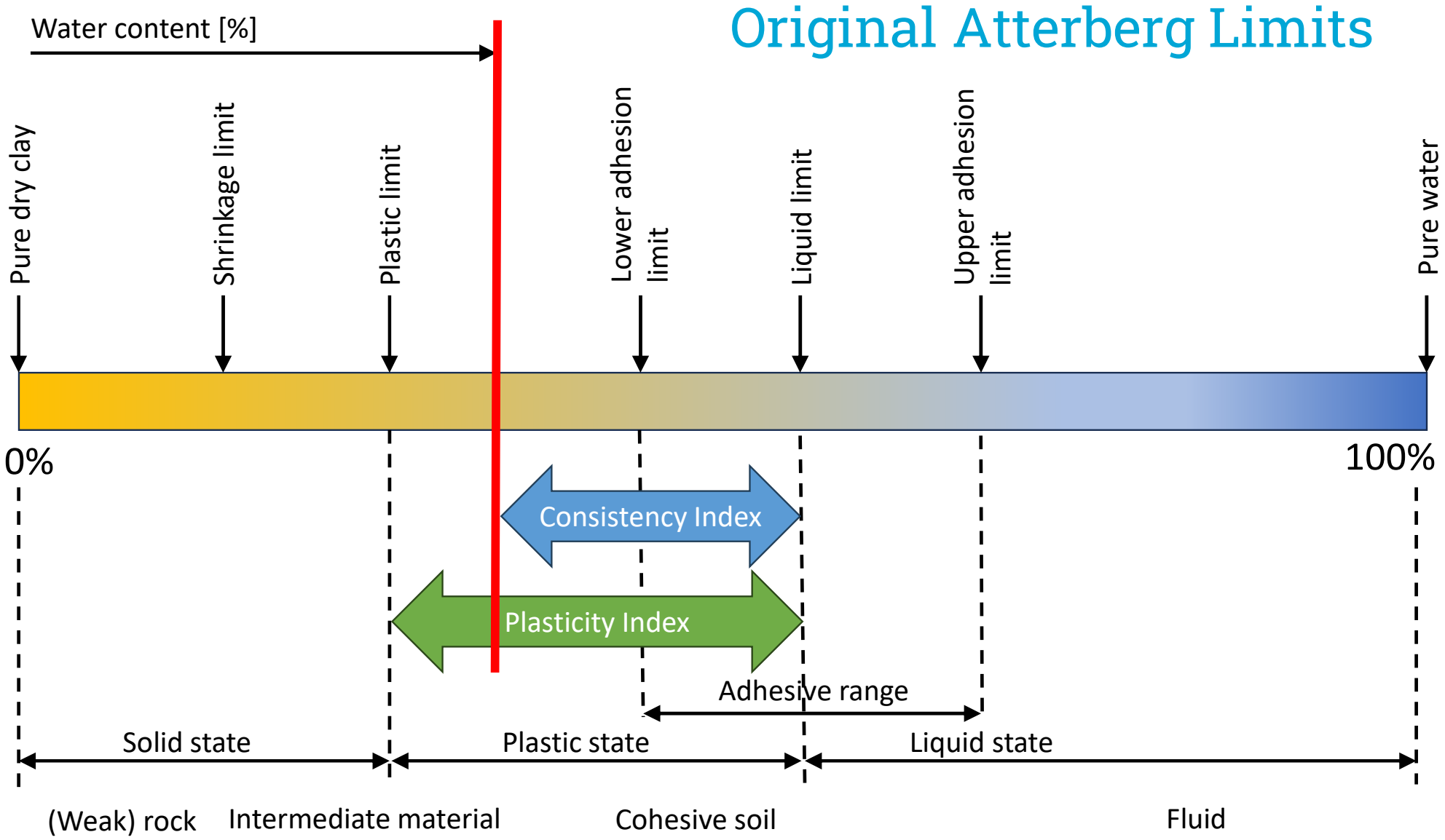
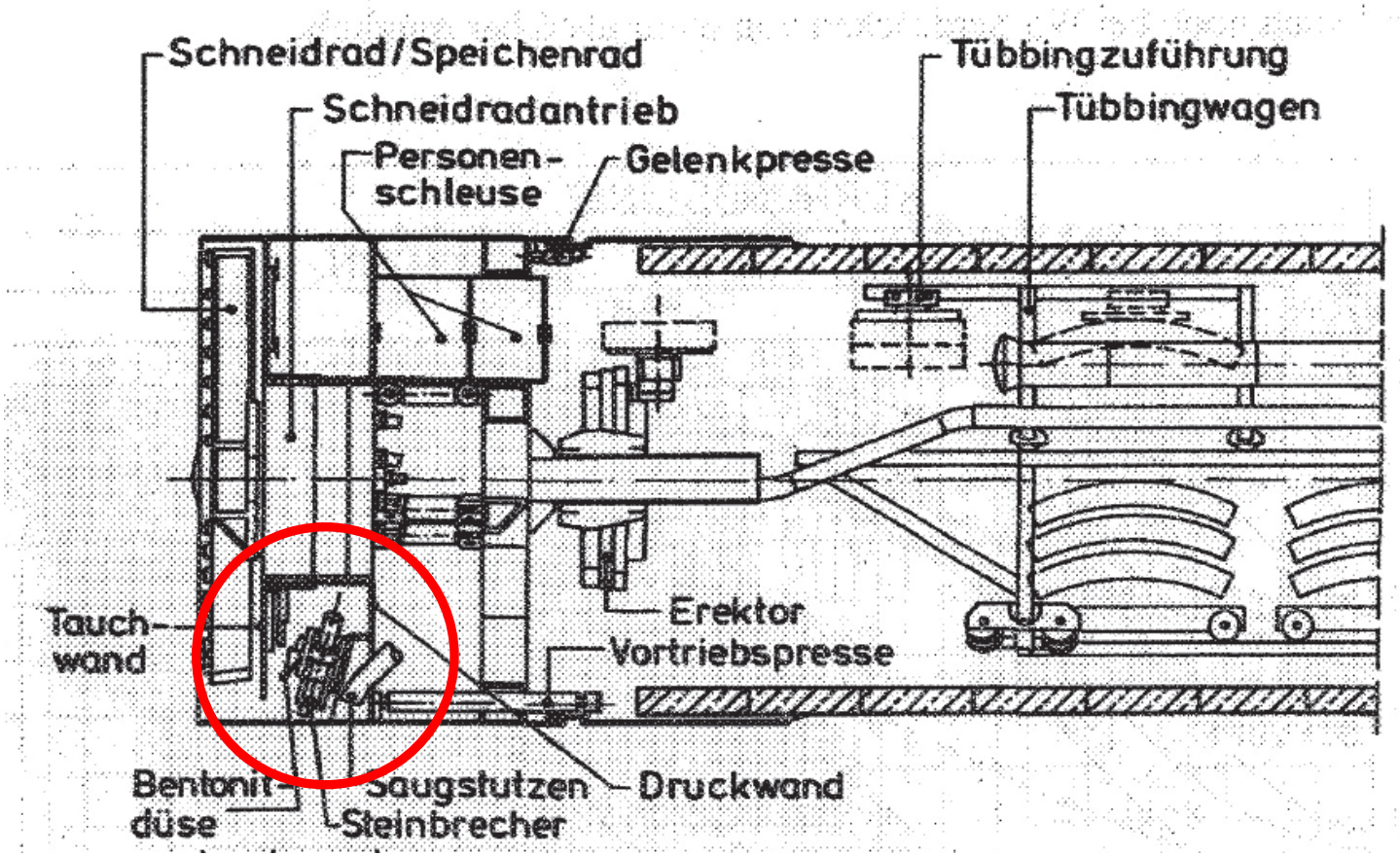
Original Atterberg Limits



PIANC Origin of the Adherence Potential: Tunneling

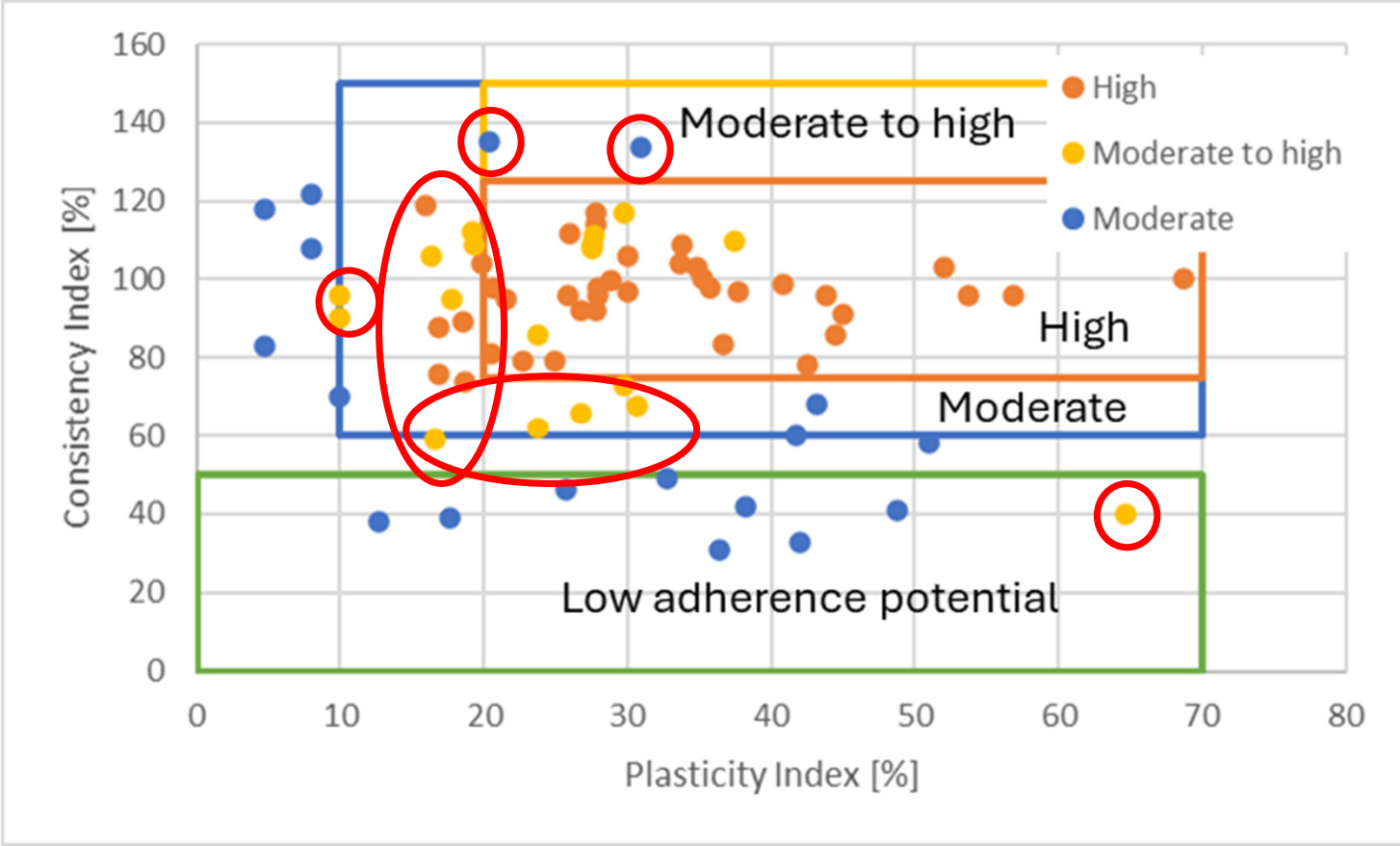
- Thewes (1999)
- Tunnel boring
- Suction problem
- Internal adherence
- Also, just literature review



Literature Data Plotted in the Adherence Recommendation

- Data from Schlick, 1989
- Classed by Thewes, 1999

- Large spread
- Creative grouping…



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Bit Balling

- Oil drilling industry
- Other parameters
- Different solutions
- Only qualitative

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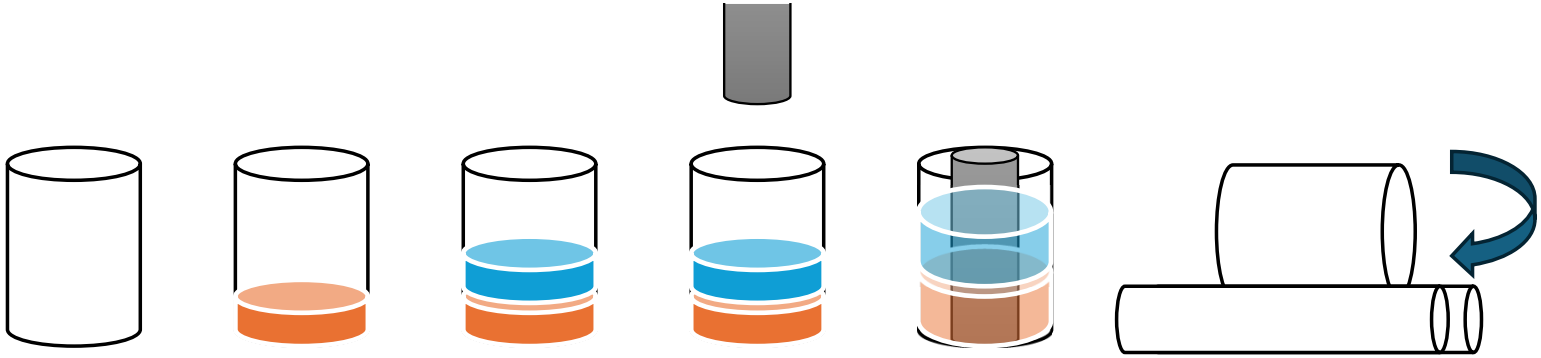
Rolling bar test



- AADE* procedure
- 50gr (1.7637oz) sample
- Match conditions (water content, temperature, pressure, materials, coatings, lubricants)
- Adherence to bar
- Prolonged churning
- Measure over time
- Plot series

*American Association of Drilling Engineers

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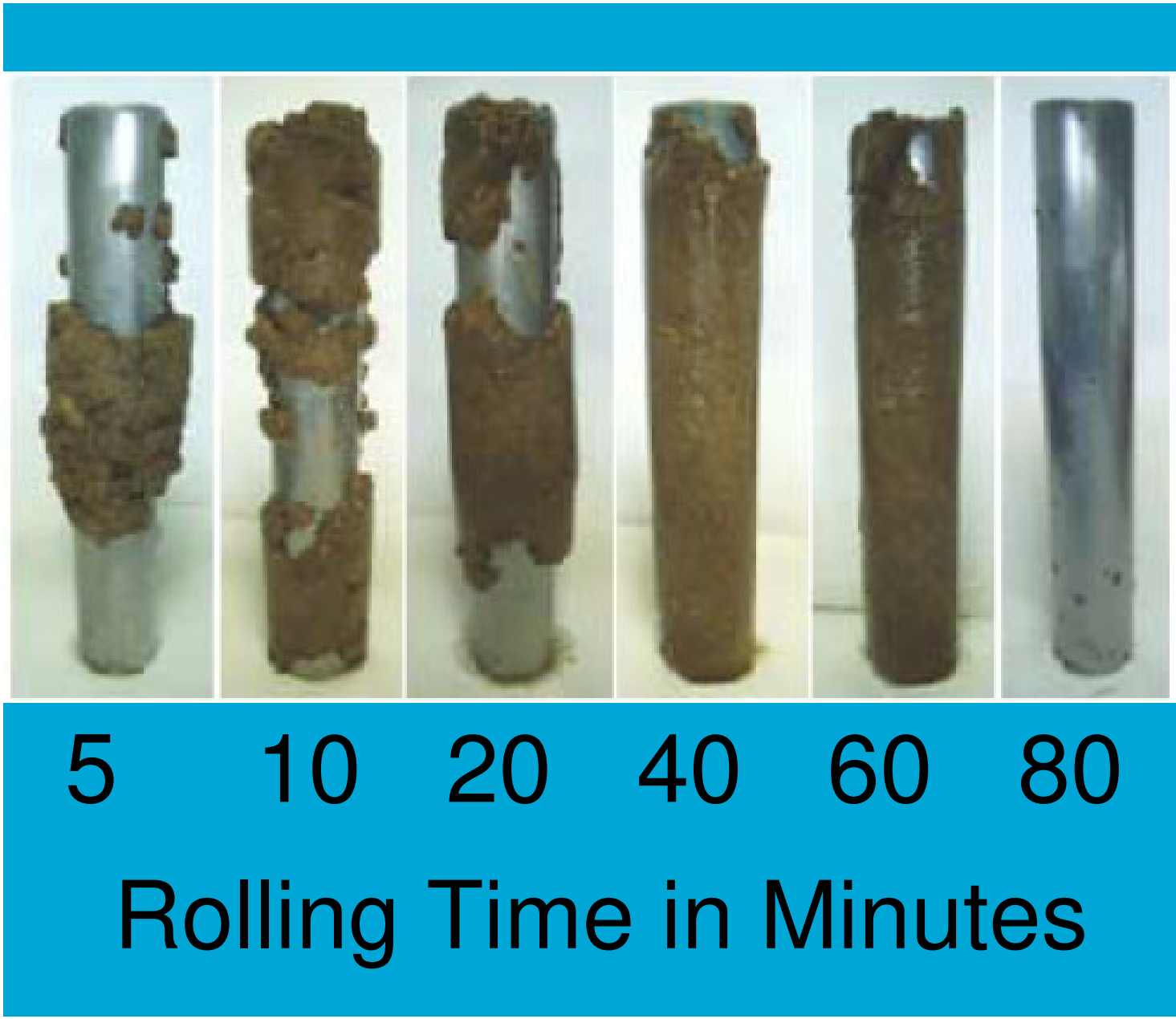
Rolling bar test

- Churning aligns particles
- Squeezes out pore water
- Changes local water content
- Changes adherence
- Past lower adhesion limit: clean rod

$$Acc = \frac{W_3}{\left(\frac{100 - M_i}{100}\right) W_1} 100\%$$



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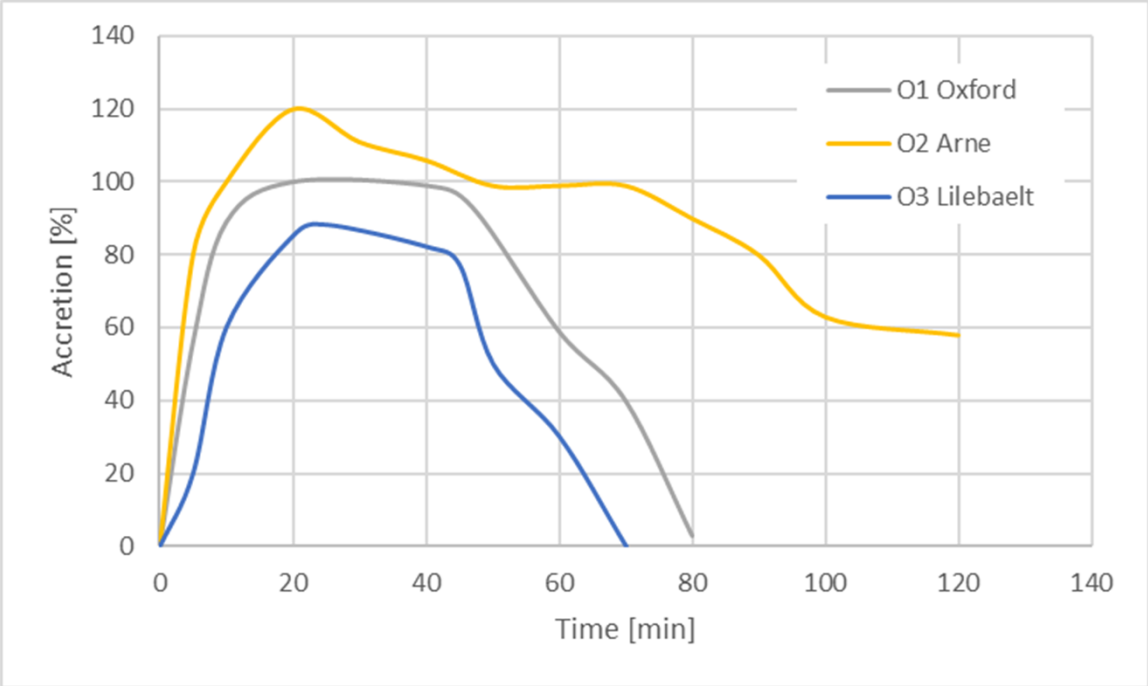
Accretion Test Results (Mettah, 2011)

		Provided			Analysed		AADE	PIANC
ID	Sample	w(%)	I_p(%)	I_l(%)	PI(%)	I_c(%)	Risk	Adherence potential
1	Oxford	3.4	25.7	40.9	15.2	246.7	Low	Off chart
2	Arne	26.5	36.3	73.2	36.9	126.6	High	Moderate to high
3	Lilebaelt	20.5	26.5	41.5	15.0	140.0	Low	Moderate

- >100% due to formula (includes water content)
- Accretion depends on time
- Oxford & Lilebaelt clean up
- Arne stays stuck to rod
- No cleaning: bit balling!



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Observations on PIANC and AADE Procedures

- Flow conditions not included in both procedures
- Time scales of clogging processes are different, check applicability of rolling bar test for dredging
- Investigate initial rate of accretion for fast cutting process
- Test teeth material in stead of stainless-steel 315
- Correlate dredging rolling bar with field results

Conclusions

- Clay recommended for construction (CROW) is also clay with highest adherence potential (PIANC)
- PIANC does not work for highly active clay, different adhesion ratio and does not include dynamic behaviour
- Rolling bar test is sensitive to more parameters (adhesion ration, Cation Exchange Capacity, shear rate, pressure)
- Propose rolling bar test for dredging in contract negotiations

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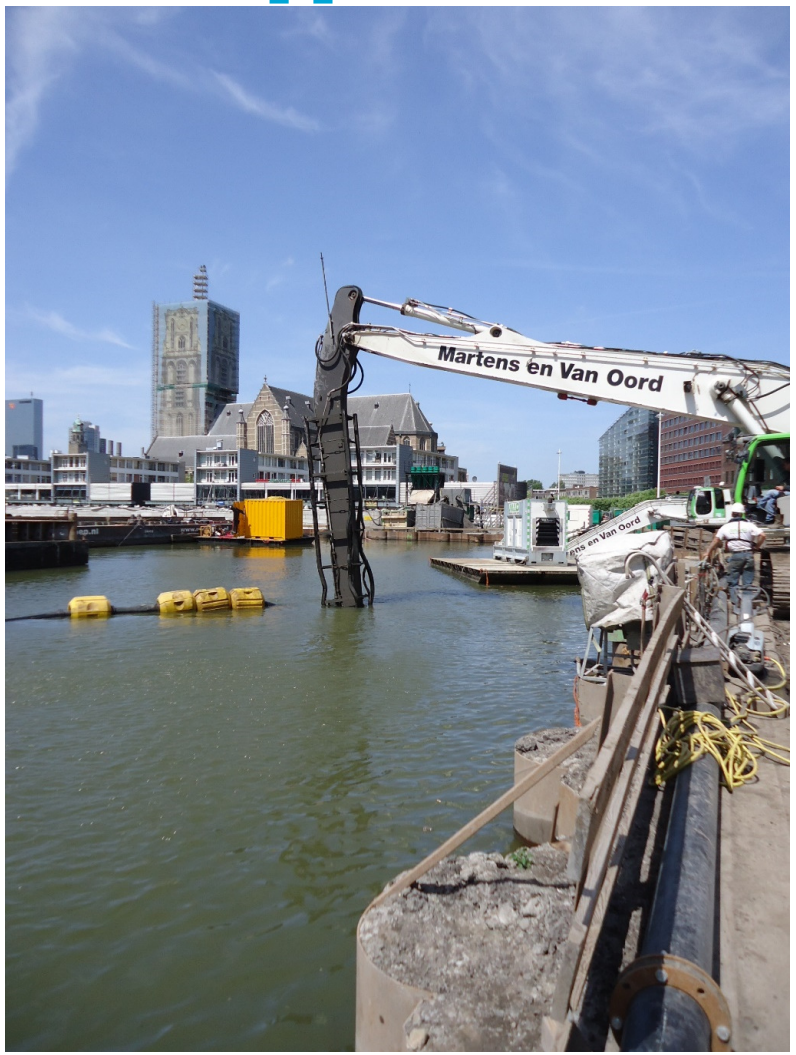
References

- PIANC (2016): PIANC Report No. 144 - C.2.1 Trailing Suction Hopper Dredger (TSHD)
- CROW (2009): Materialen in (constructieve) ophogingen en aanvullingen; Richtlijn ter beoordeling van alternatieven voor zand
- Thewes (1999): Bodenmechanik und Grundbau, Bericht - Nr.21, Juli 1999
- Schlick (1989): Institut für Maschinenwesen im Baubetrieb, Universitlät Karlsruhe, 1989, Heft F39
- Mettah (2011): The Prevention and Cure of Bit Balling in Water-Based Drilling Fluids


Improvise. Adapt. Overcome

Plastic Clay in the Foundation: DOP application



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Working With Nature: Apply Adhesion

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Thank you for your attention

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