Iain Steven, Cedeco Contractors Ltd

Foundation innovations; the journey of a micro SME from the….

Scottish Power Renewables (SPR)

and

Offshore Renewable Energy Catapult (OREC)

2018 competition

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The OREC / SPR competition challenge details

- **Connection pile-to-jackets R&D requirements:**

Objective: To develop improved and/or new systems to;

- **Improve on bottom stability**
- **Reduce vessel utilisation**
- **Reduce weather window requirements**

Expectations (based on existing concepts):

- **Mechanical connection (e.g. grippers, clamps)**
- **Remotely activated, from the surface; no ROV**

Time:

- **Temporary (while grout is installed and cured), or**
- **Definitive (instead of grout)**

Stabilisation

- **Partial (to work in conjunction with other systems, e.g. grout).**
- **Total (not to rely on other stabilizing means).**

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Primary impacts: cost reductions of £215 - £290k per foundation

Clamp Cost	Cost Saving Per Foundation (£)		
	Lower Bound	Best Estimate	Upper Bound
£50,000	£71,000	£290,000	£595,000
£75,000	-£1,500	£215,000	£495,000
£100,000	-£79,000	£140,000	£395,000

TABLE 3 SUMMARY OF PER-FOUNDATION COST SAVINGS AND SENSITIVITY STUDIES

1. Reduced jacket leg length
2. Avoid need for 2-50m³ of high strength grout per foundation
3. Avoids need for a grout spread, personnel and vessel
4. Avoids the need for a grout seal
5. Avoids the need for grout lines
6. Avoids the need for a pile-top anti-vibration clamp
7. Reduced costs by avoiding need for Shear Key weld beads

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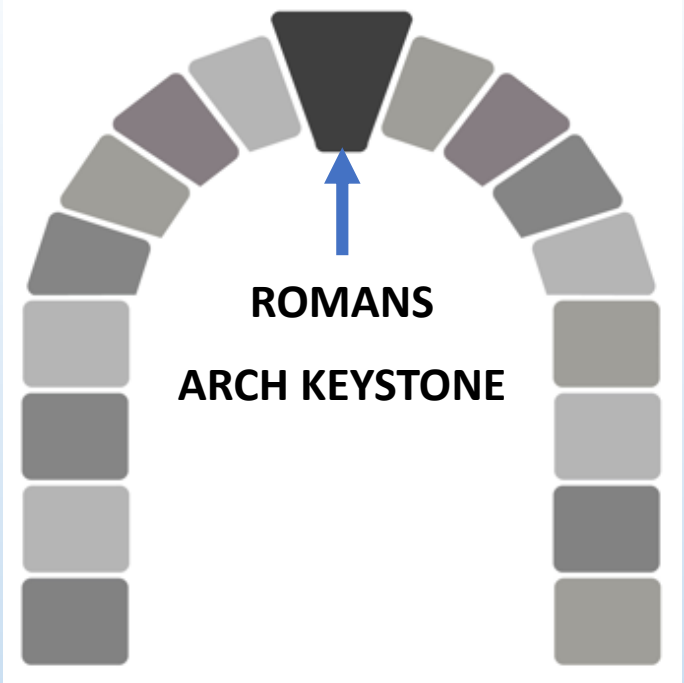
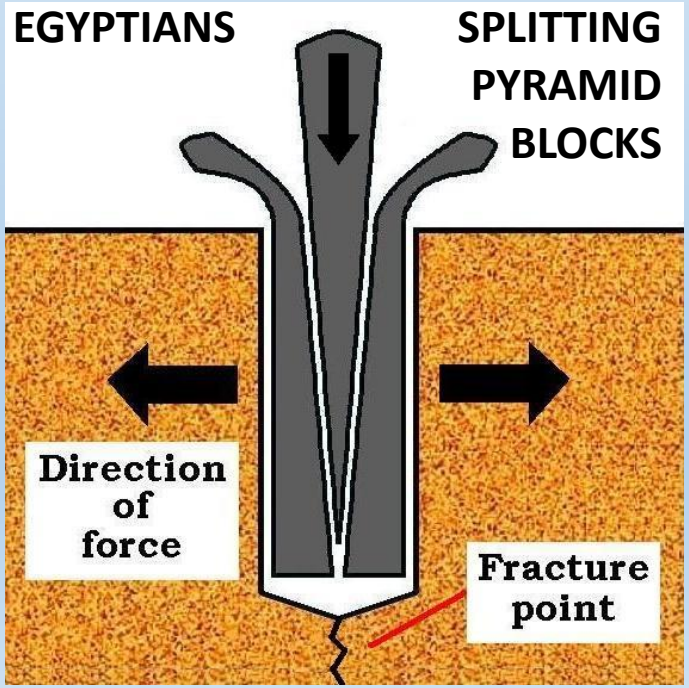
Potential Benefits:

1. Reduction in overall installation through better use of heavy-lift vessel time & reduced weather window waiting / down time
2. Simplified design allowing future upscaling lower leg region
3. Simplified in-field vessel logistics, giving improved Health and Safety
4. On-bottom stability improved
5. Fully reversible for decommissioning
6. Less grout, better for the environment

Tapers & wedges





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BACKGROUND PATENT

RACK CHOCK AND
JACKING

SWEDEN - SKF

PROPELLER SHAFT COUPLINGS

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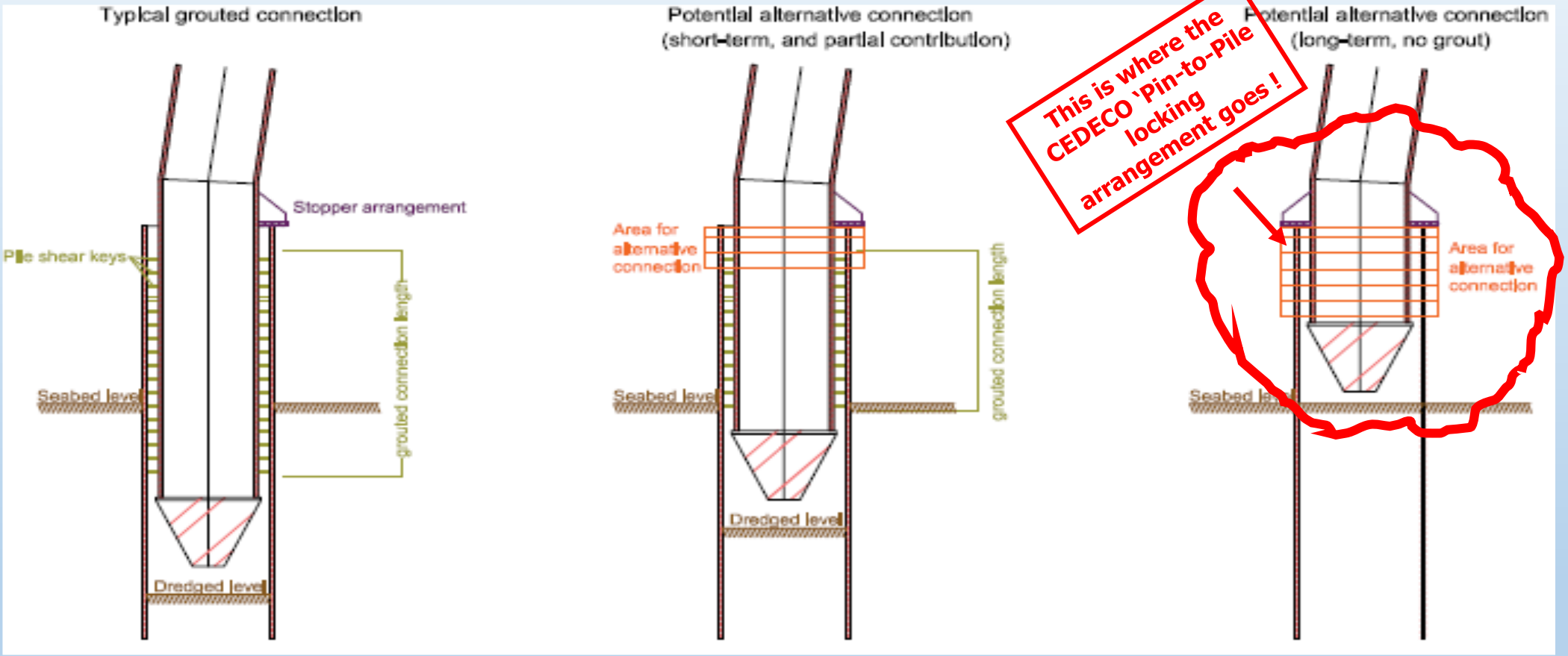
THIS IS WHAT HAS GUIDED US



Left and Centre are the basic methodologies of current Jacket Pin locking with the Seabed Pile

CEDECO Jacket Pin locking with the Seabed Pile

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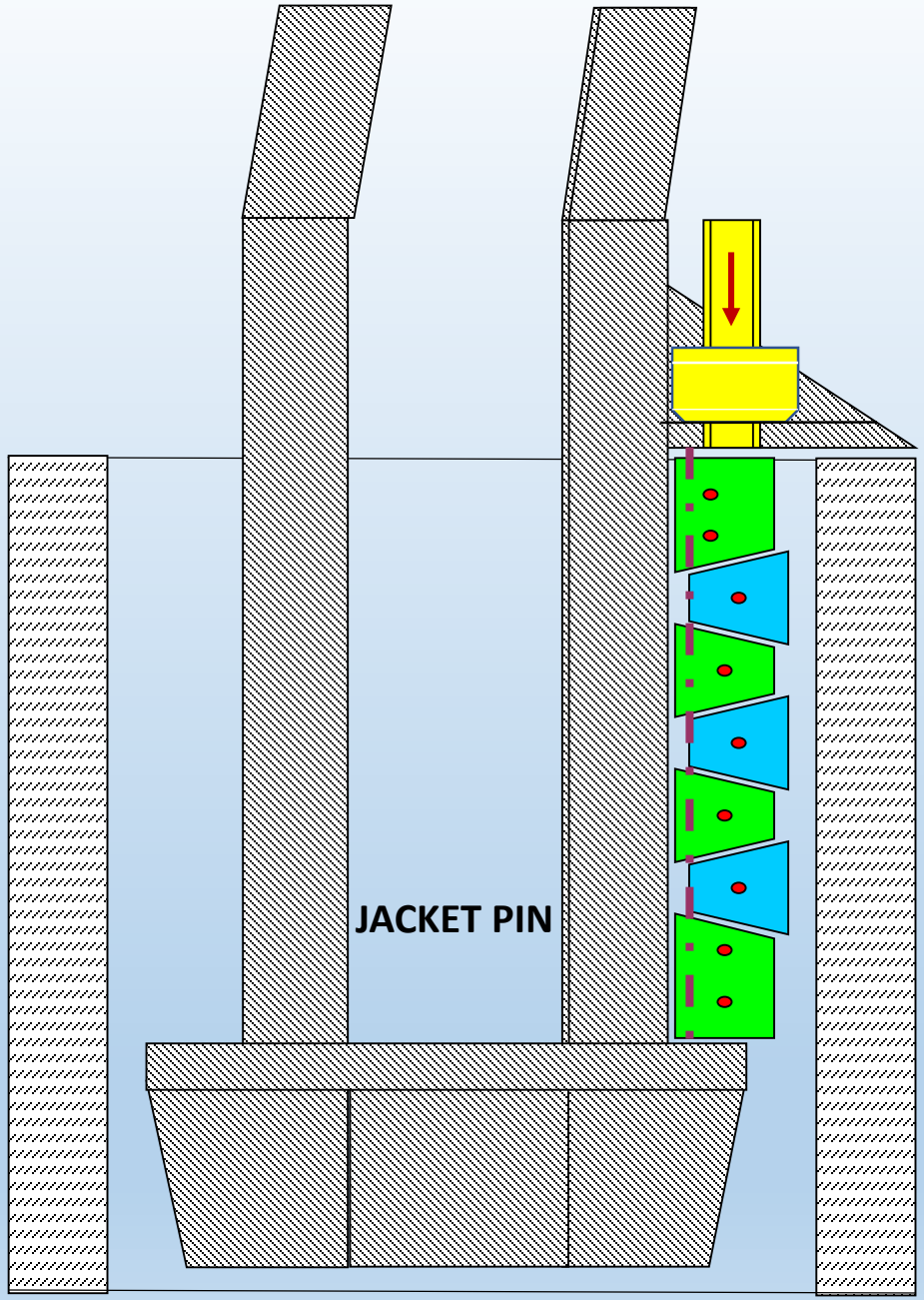

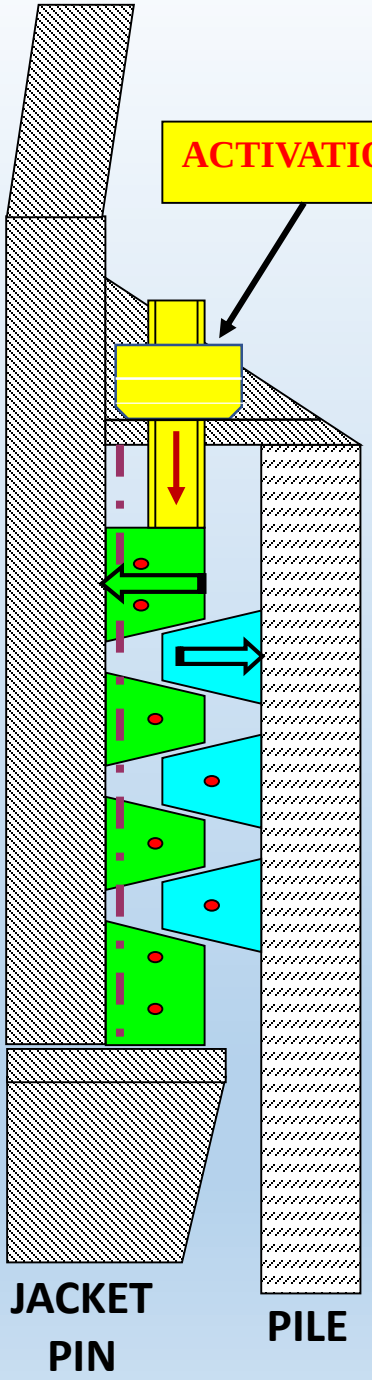

ACTIVATION SYSTEM PRINCIPLE

1) ACTIVATION - Primary function actuates the wedge action

2) Wedge sections expand inwards to compress the Jacket Leg Pin

3) Wedge sections expand outwards to grip Inside Diameter of Pile

NOTE;-
The functionality shown in this image, is a depiction only, and is NOT the actual Mechanism

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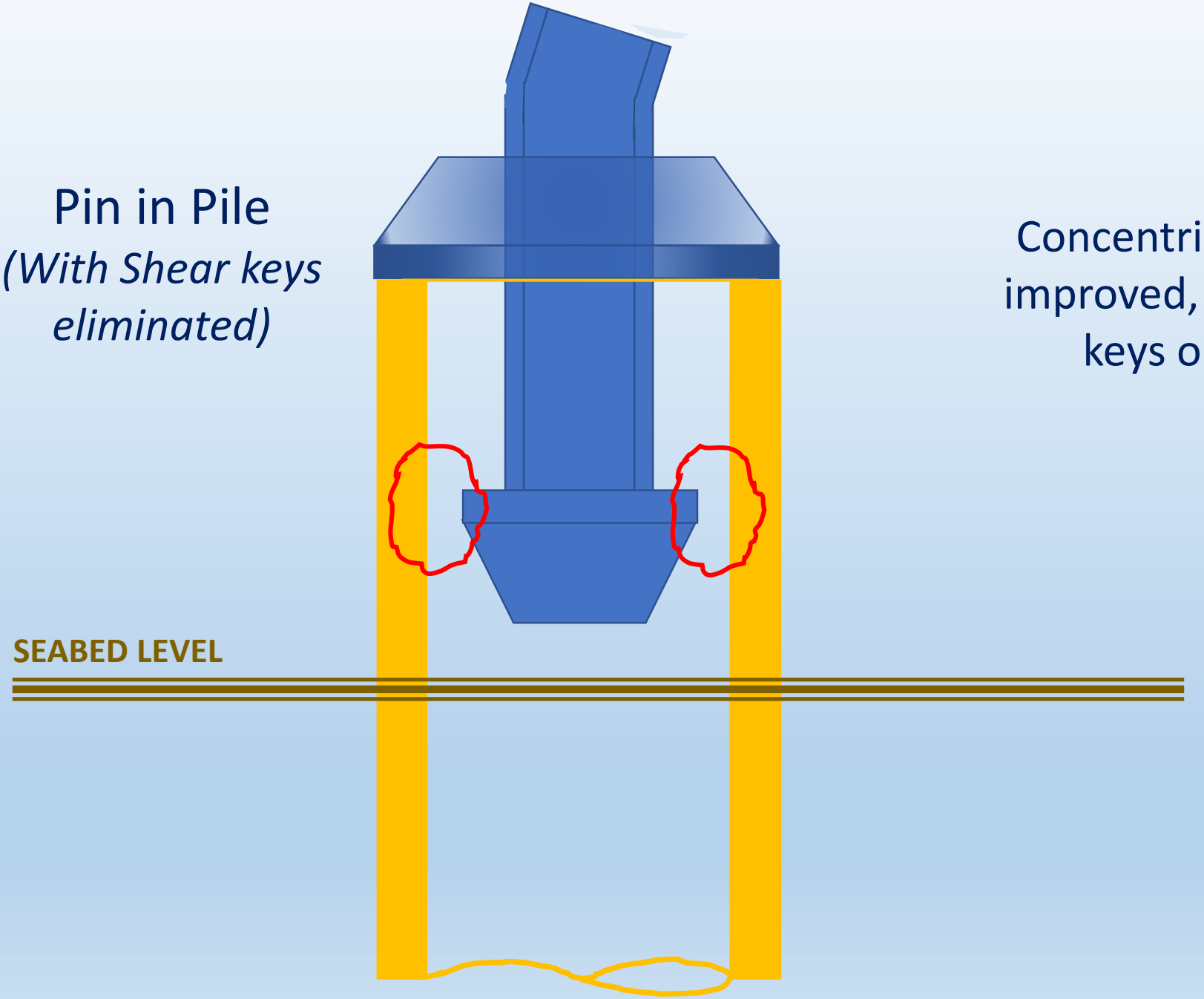
Pin in Pile

(With Shear keys eliminated)



Concentricity can be improved, once shear keys omitted.

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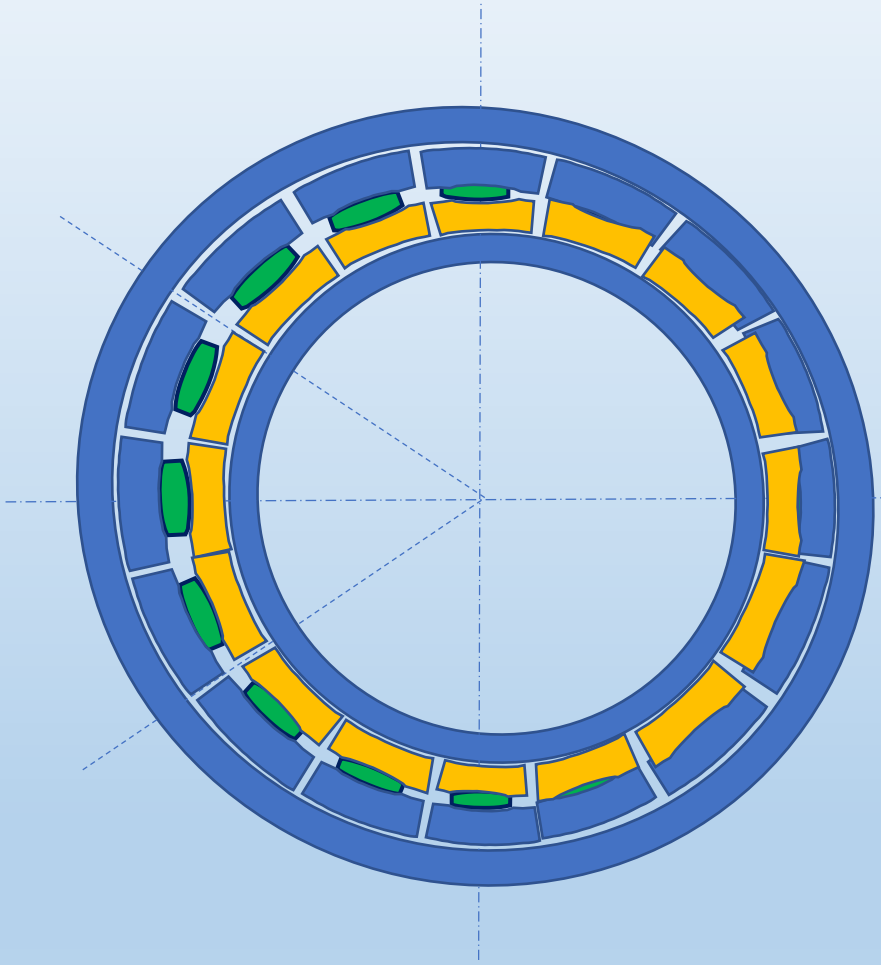
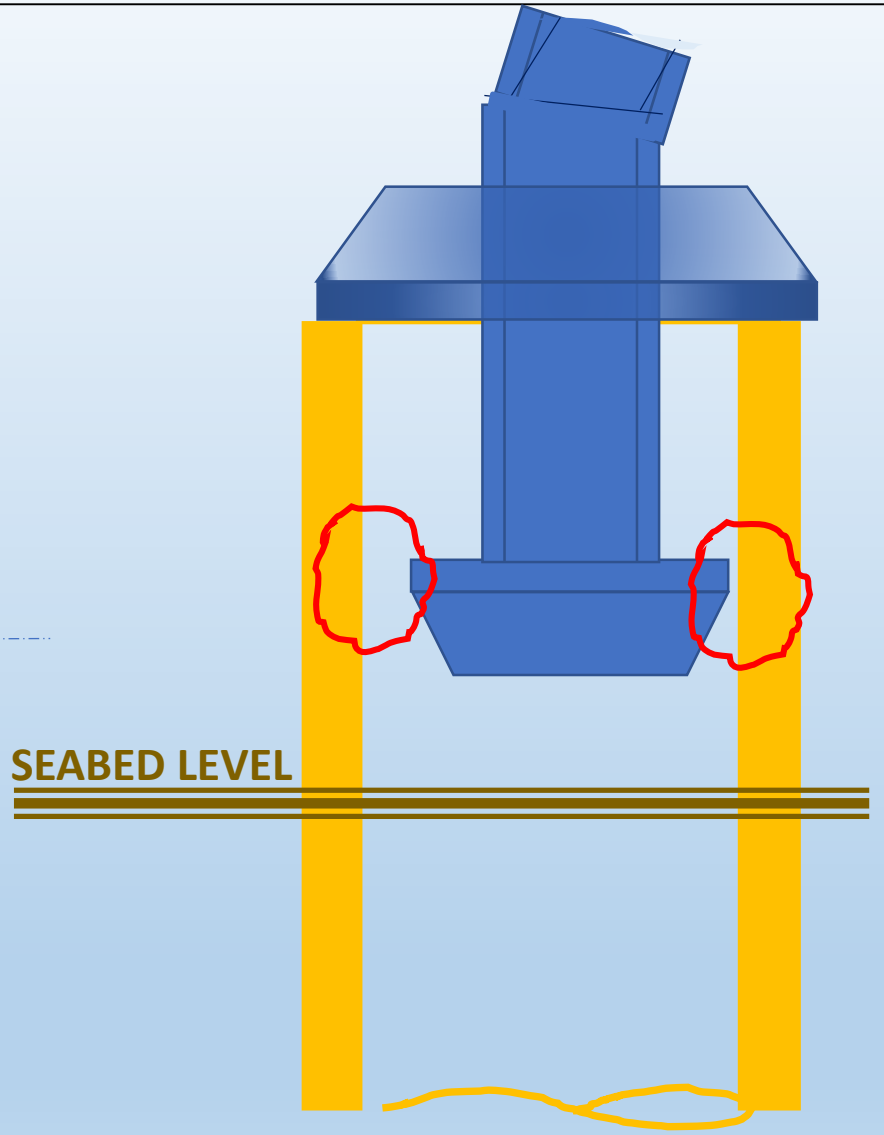
Eccentric position leg ‘Pin-in-Pile’ gripper.





Jacket Leg Pin unguided in the Pile.

Concentricity exceeds that which the gripper can function

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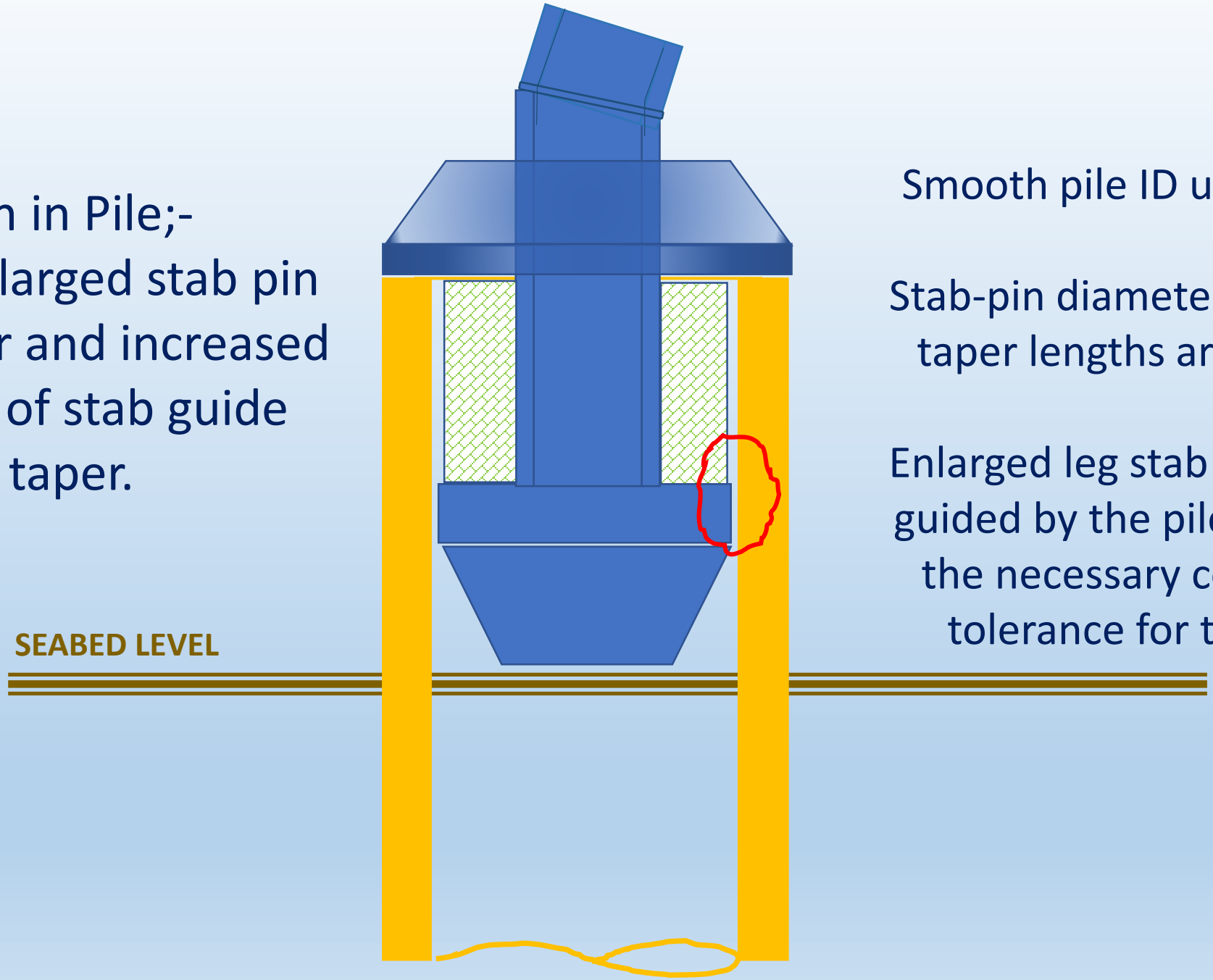
Pin in Pile;-
With enlarged stab pin diameter and increased length of stab guide taper.



Smooth pile ID used to guide.

Stab-pin diameter and stab pin taper lengths are increased.

Enlarged leg stab pin and taper, guided by the pile ID, achieves the necessary concentricity tolerance for the gripper

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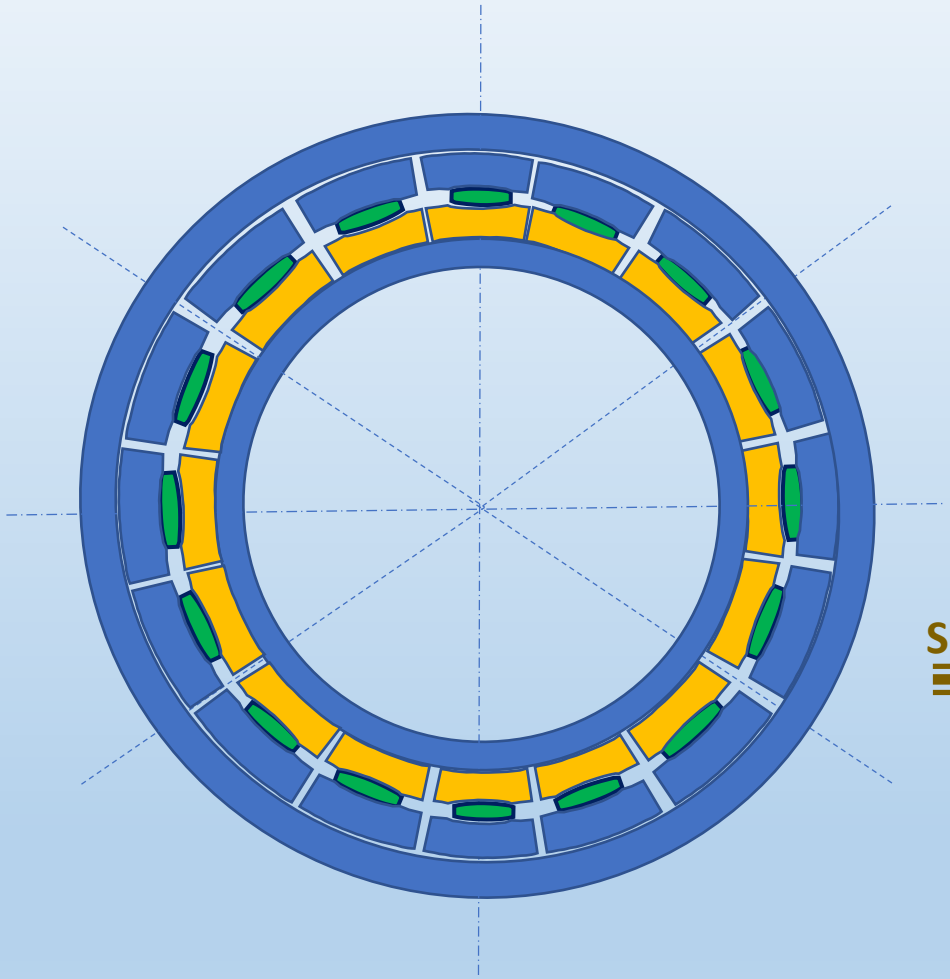
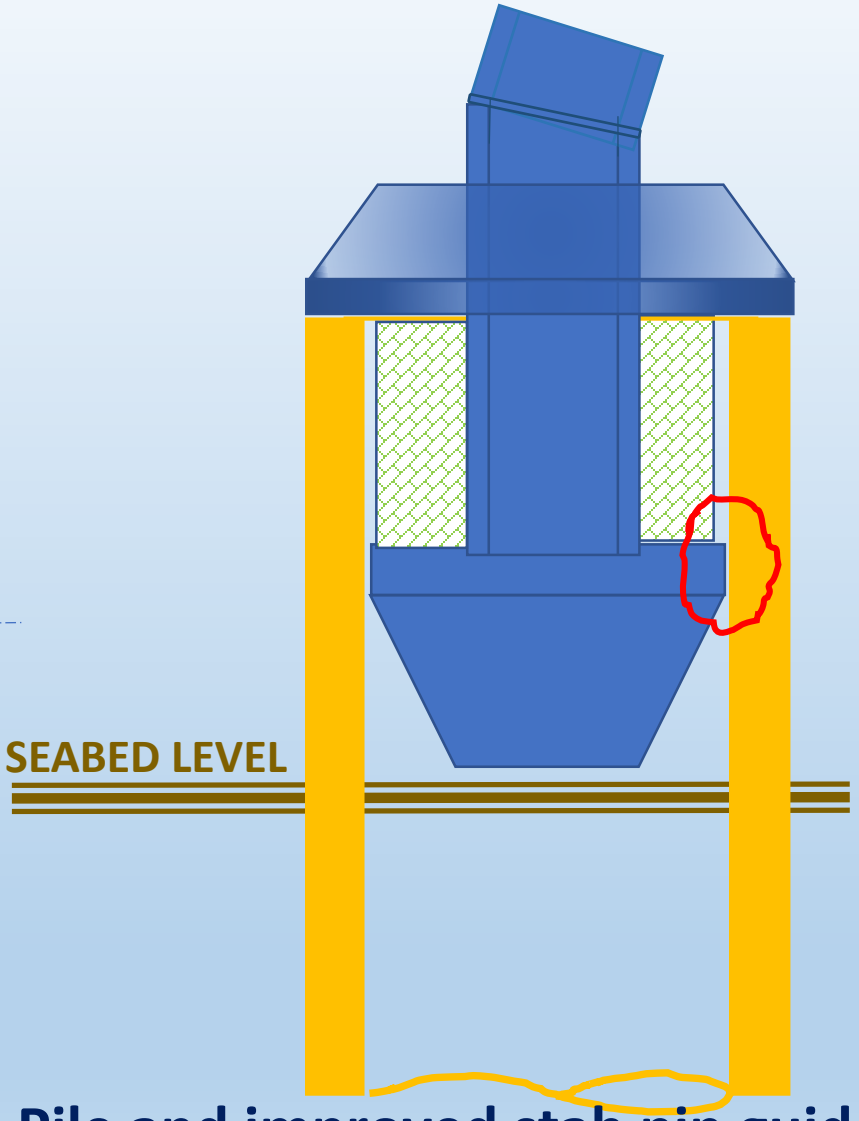
Concentric position leg 'Pin-in-Pile' gripper.





Jacket Leg Pin guided using smooth ID of the Pile and improved stab pin guide.

Concentricity improvement to where the gripper can function

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FAQ’s about the gripper function:

1. Concentricity / eccentricity for the gripper?
2. Gripper physical function, how do you know it’s worked?
3. Gripper loading, how do you know its been achieved?
4. Inspection after installation?
5. Corrosion prevention?

Design challenges

1. Selecting the most appropriate materials.

2. The most appropriate surface finish on the gripper faces and defining the grip force necessary against uplift.

3. Simplifying the activation system to be reusable and cost effective.

4. Verifying the gripper mechanism is maintaining the gripper force during years of operation.

5. Consideration of this new approach, how the gripper design could be utilised for greater loads that will be experienced in future generations of larger and taller turbines in deeper water.

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Thank you for your time