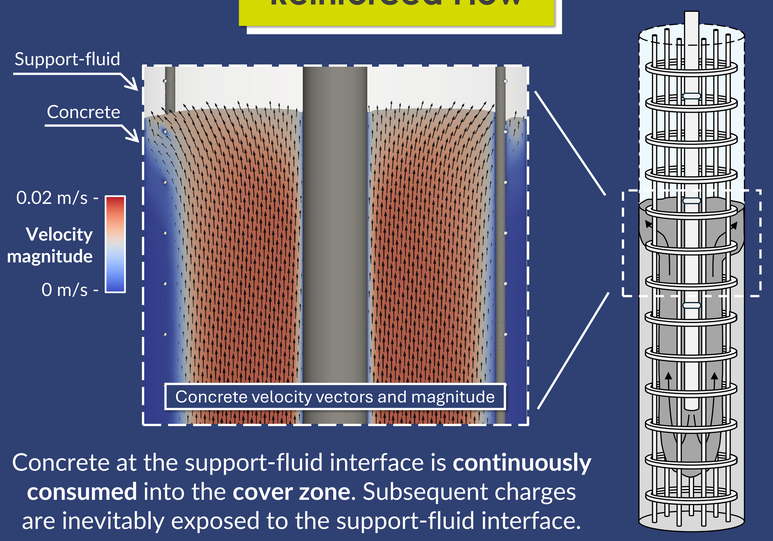
Increased flow restrictions in deep foundation elements increase the likelihood of **defect generation**.

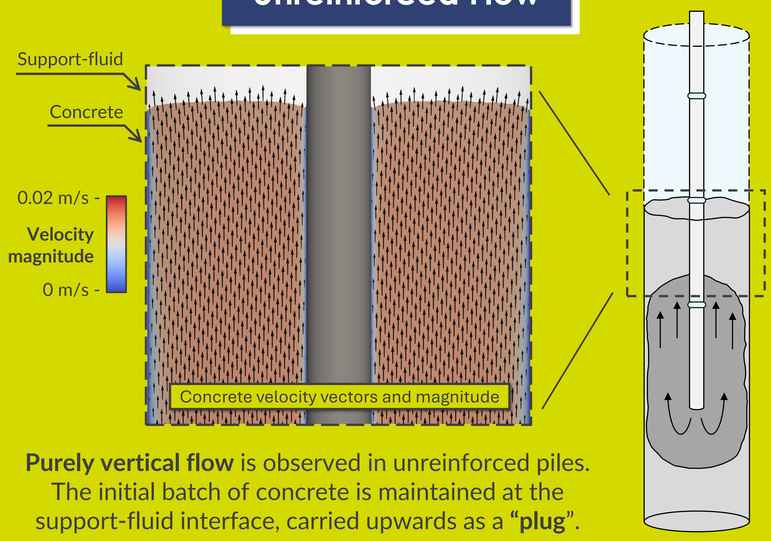
BGA Annual Conference 2025

Reinforced Flow



Concrete at the support-fluid interface is **continuously consumed** into the **cover zone**. Subsequent charges are inevitably exposed to the support-fluid interface.

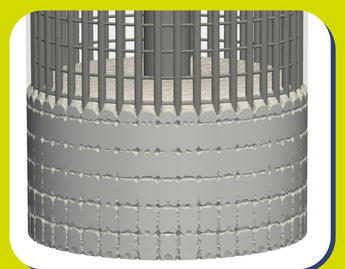
Unreinforced Flow



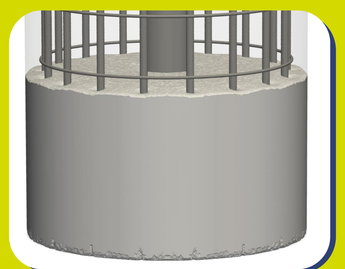
Purely vertical flow is observed in unreinforced piles. The initial batch of concrete is maintained at the support-fluid interface, carried upwards as a **"plug"**.

Multiple Flow Restrictions

Restricted Flow



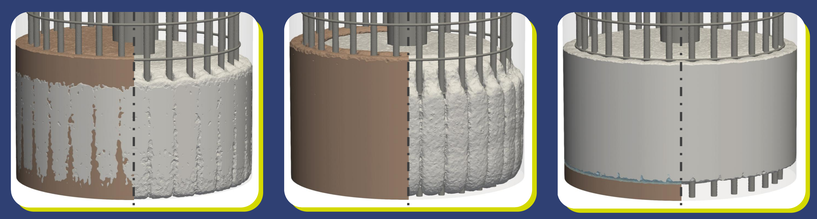
Unrestricted Flow



Introducing **multiple flow restrictions** (such as low workability concrete, minimal cover zone, and reduced reinforcement clear spacing) **reduces the available kinetic energy** in the concrete, thereby reducing its ability to effectively fill the cover zone and **increasing the likelihood of defects**.

Insufficient Base Cleaning

Increasing sediment yield stress (increasing clay fraction) →



Sediment on the pile base before pouring can restrict the flow of concrete within the cover zone, resulting in **shadowing and insufficient cover.**

The final distribution of sediment, and thus the **severity of defects**, is highly dependent on the **rheological properties** of the sediment.

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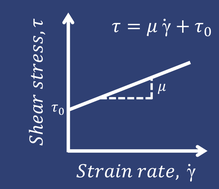
Background

- **Increased loading requirements** for deep foundation elements result in larger and deeper foundations, and thus longer concrete pours.
- Upon exposure of deep foundation structures, **defects and imperfections,** including mattressing, voids, and insufficient cover, are occasionally revealed, leading to costly delays.
- There is a **lack of understanding** of the concrete flow mechanisms that occur during the pouring phase of construction and how these contribute to defect generation.

Methodology

- **Computational Fluid Dynamics (CFD)** based numerical modelling is used to investigate the flow mechanisms behind the pouring process and draw links to their influence on defect generation.
- **Parametric studies** are conducted, varying reinforcement clear spacing, cover zone size, concrete workability, tremie embedment, and the existence of sediment on the pile base.
- Fresh concrete's rheological behaviour is captured with a **non-Newtonian Bingham fluid** model.



Conclusions

Flow restrictions increase defect generation

E.g. low-workability concrete, minimal cover zone, reduced reinforcement clear spacing, insufficient base cleaning.

Pile design should be a holistic process

Consider concrete flow and structural requirements in tandem, with collaboration between engineers and contractors.

Two bulk flow mechanisms exist in bored piles

The dominant flow mechanism is dependent on the level of reinforcement within the element.

Numerical modelling is a powerful tool

Measuring slump-flow and slump-flow velocity on site allows for concrete flow to be modelled.

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Mitchell, T., 2024. Numerical modelling of tremie concrete in deep foundation construction. PhD thesis, Swansea University