

An underwater scene showing a large, coiled anchor chain resting on a sandy seabed. The water is clear blue, and there are some small plants and rocks scattered across the sand. The anchor chain is the central focus, with its links and shank clearly visible.

# Calibration and implementation of a design tool for drag anchors in clay

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# Agenda

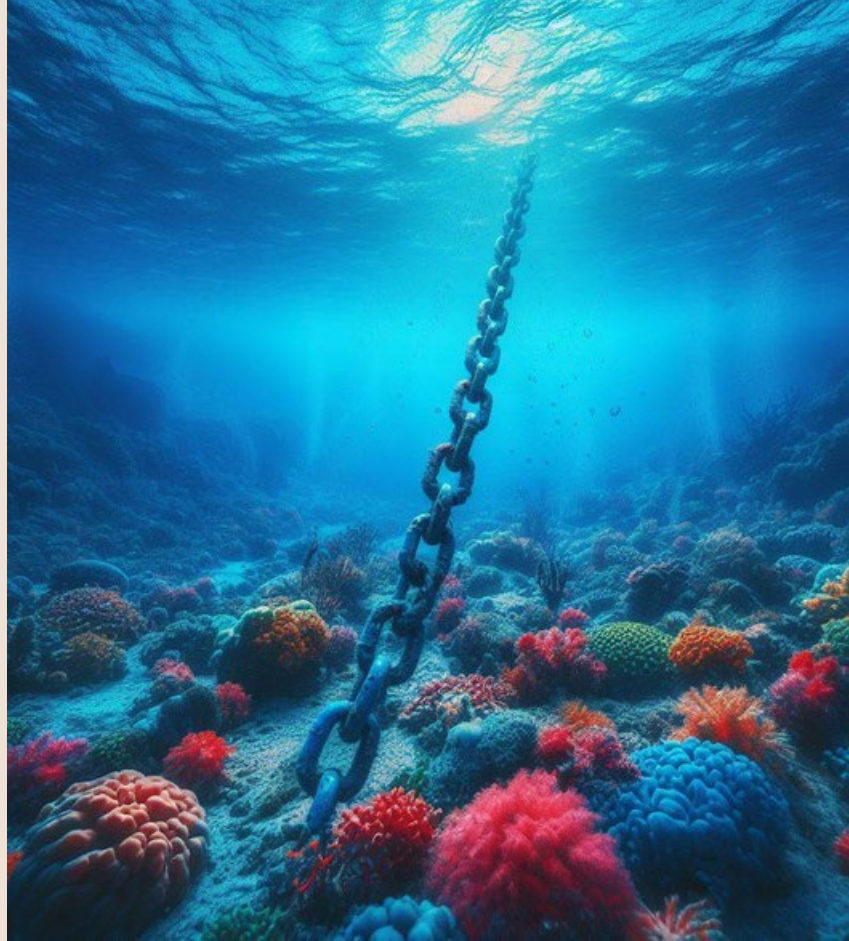
Drag anchors and design requirements

Design methods

Calibration of a drag anchor tool

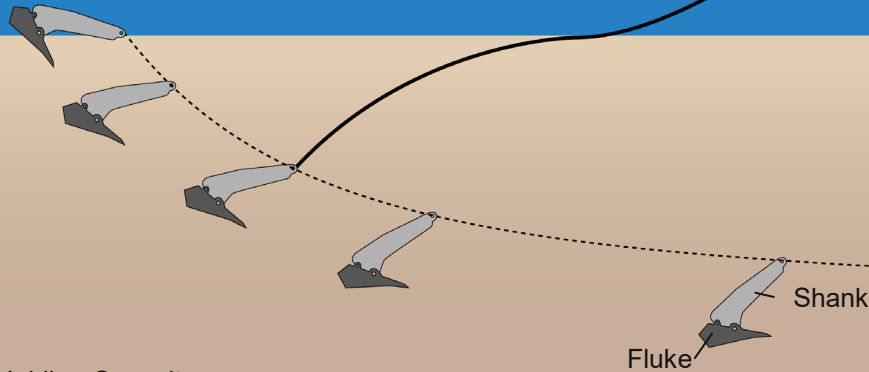
Sensitivity of parameters

Conclusions



# Drag Anchors (fluke anchors)

- › Plough-like anchor
- › Installed by drag after a vessel
- › The anchor self-embed during installation
- › No further penetration when UHC is reached



## Pros

- › Low material usage

## Cons

- › Can sustain limited uplift force (usable for catenary mooring systems)
- › High bollard pull requirements for installation vessels

UHC = Ultimate Holding Capacity

# Anchor Comparison for Floating Wind

## Aim:

Comparison of anchor size for feasibility studies (basic design, ...)

Simple design tools/methods are needed

## Situation:

Suction anchors

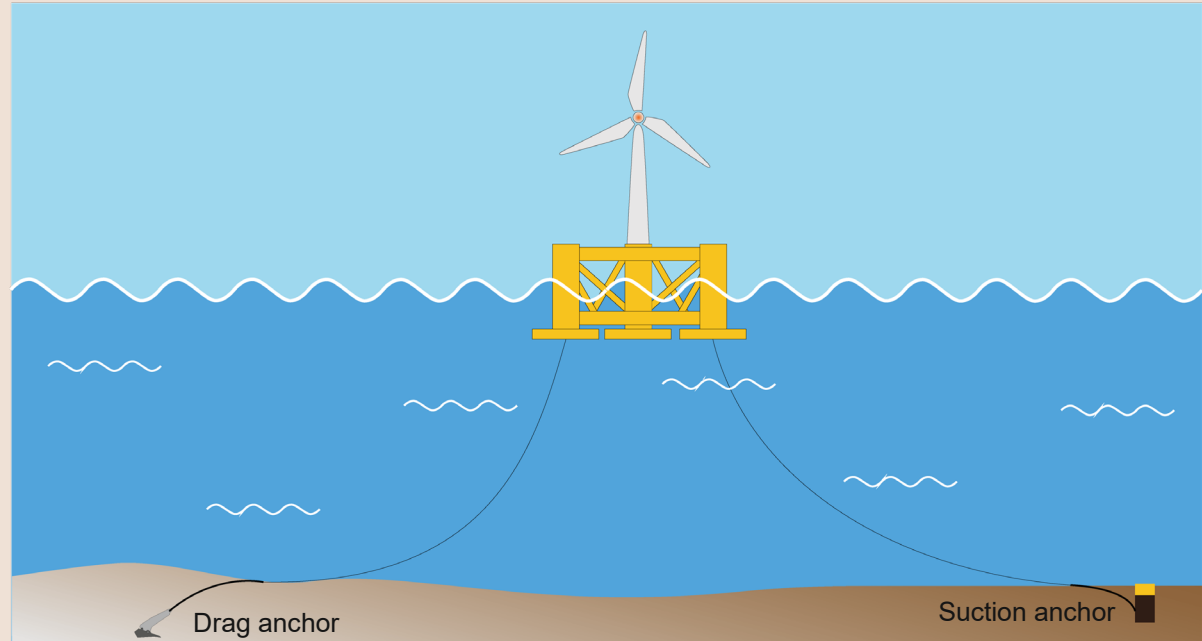
- › Simple analytical solutions
- › Can account for local soil conditions

Drag anchors

- › Design diagrams
- › Limited to very few generic soil conditions

## Need:

We need a method to make simple, but more accurate, predictions for drag anchor design



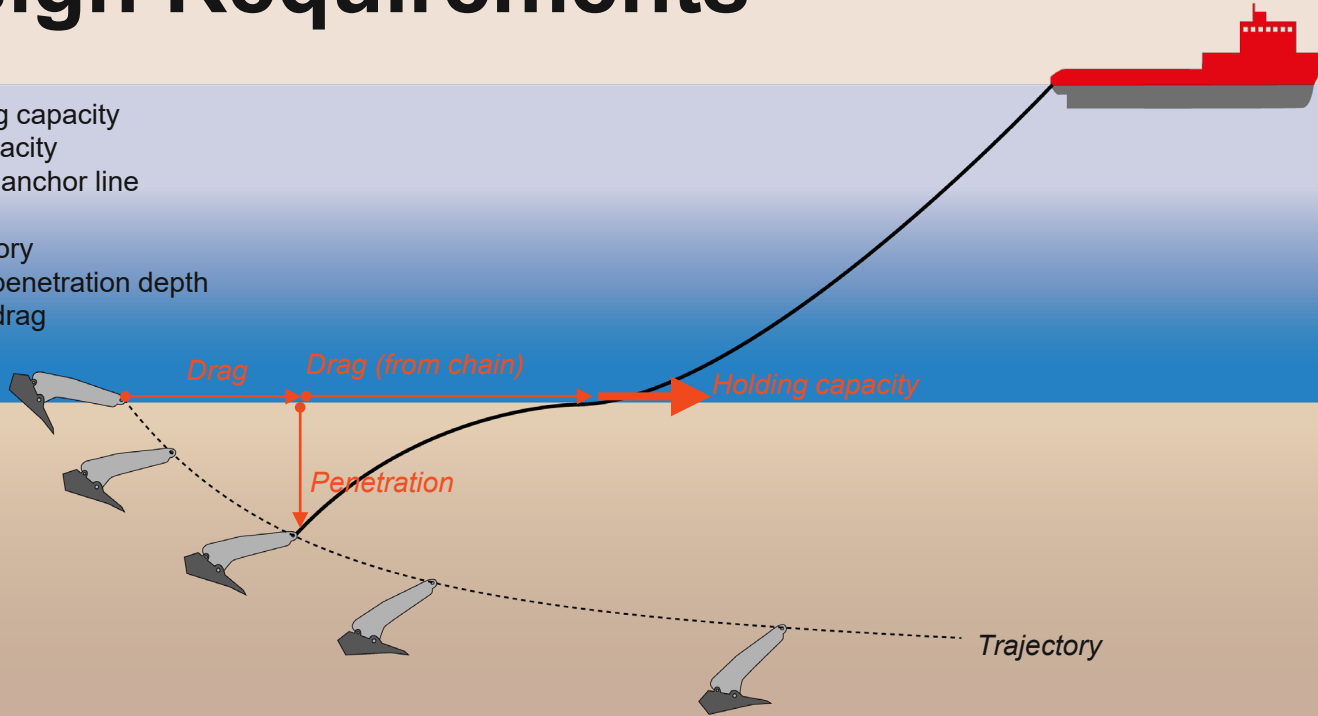
# Design Requirements

## Anchor holding capacity

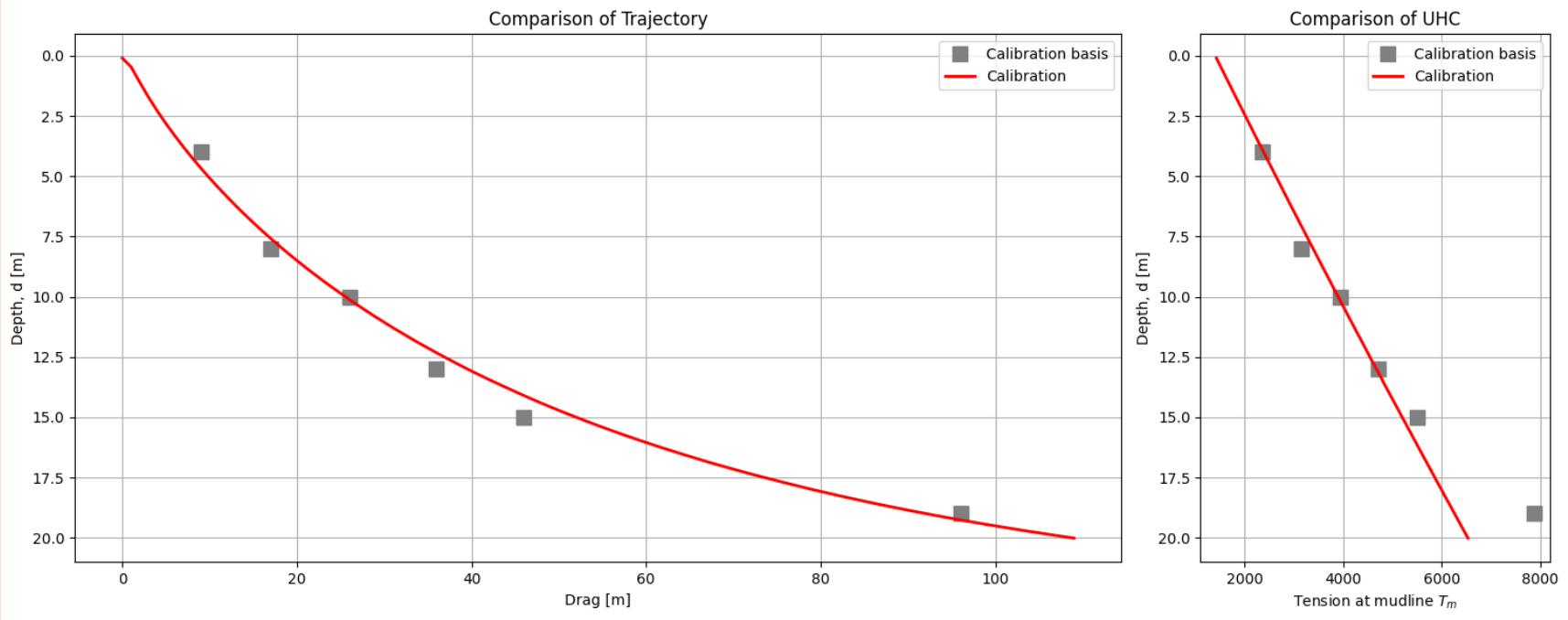
- › Anchor capacity
- › Embedded anchor line

## Anchor trajectory

- › Estimated penetration depth
- › Estimated drag

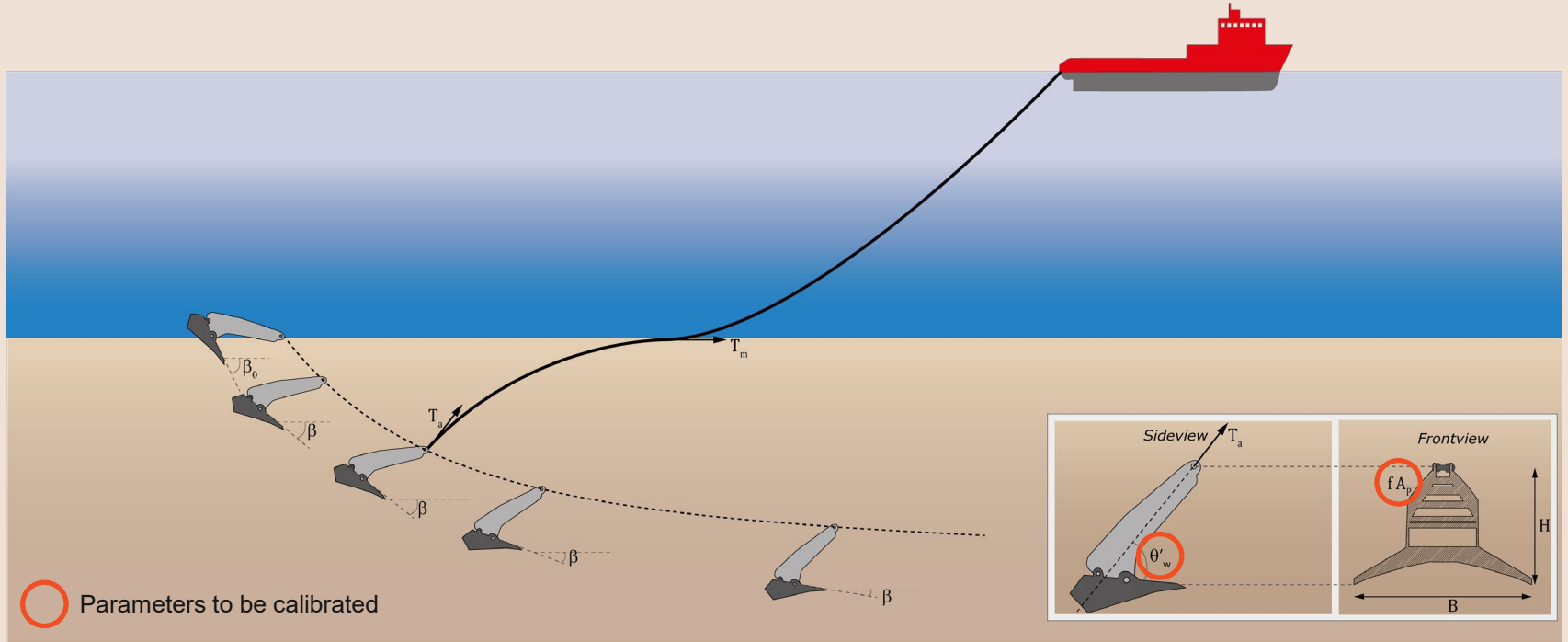


# Calibration to Soft Clay



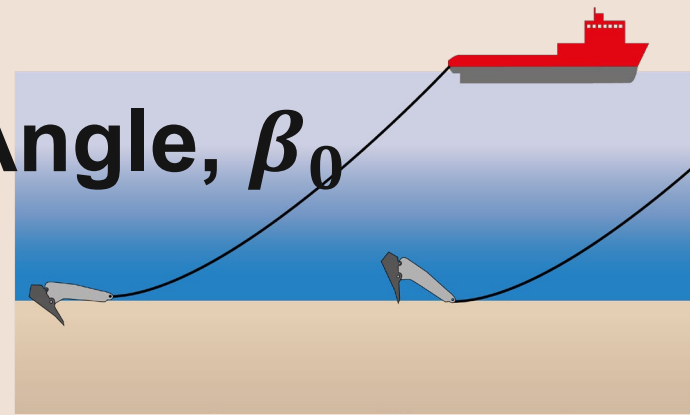
# Design Methodology (UWA methodology)

Method from Offshore Geotechnical Engineering by Mark Randolph and Susan Gourvenec

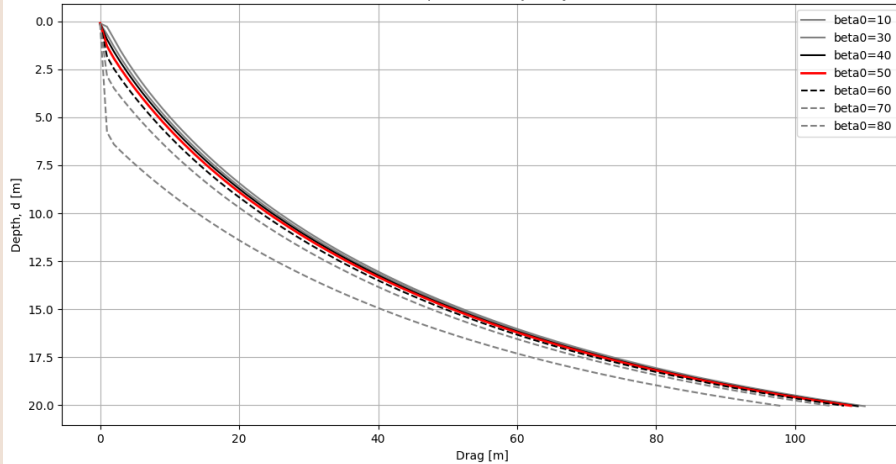


# Sensitivity of Initial Fluke Angle, $\beta_0$

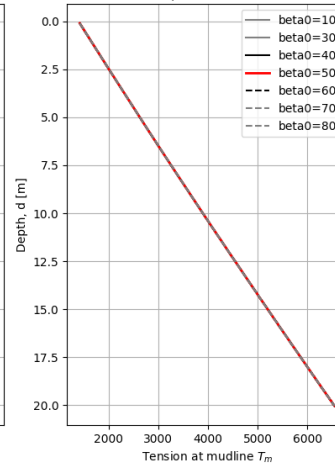
- › Only extremely large values of initial fluke angle will be problematic
- › For non-extreme values, insignificant effect is found on trajectory and UHC



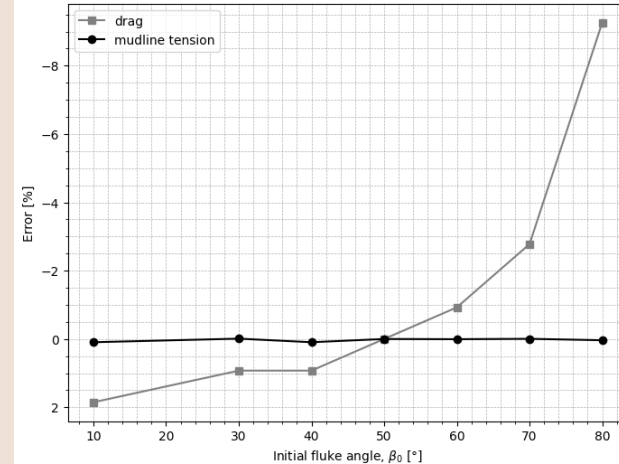
Comparison of Trajectory



Comparison of UHC



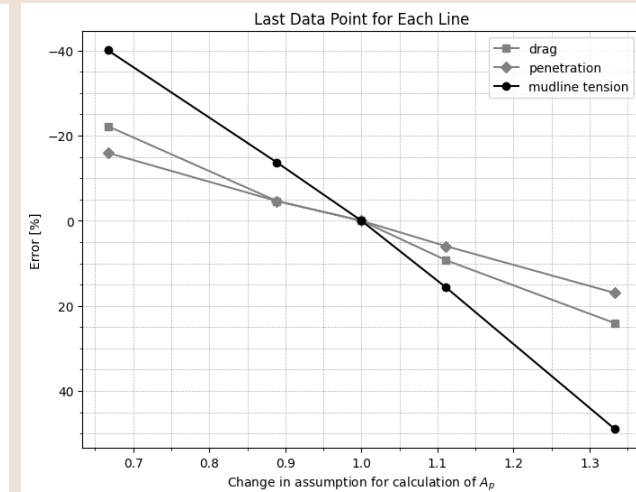
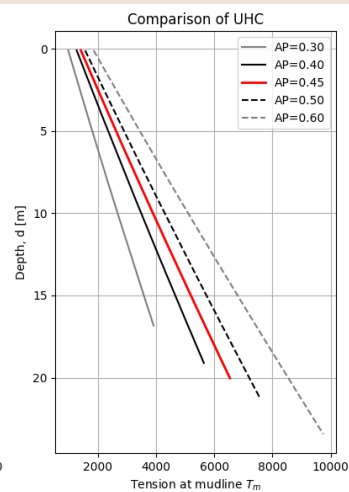
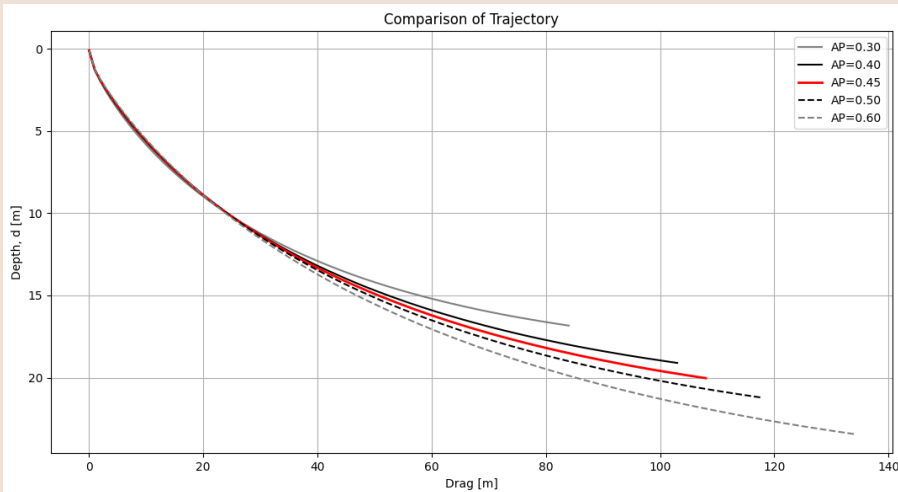
Last Data Point for Each Line





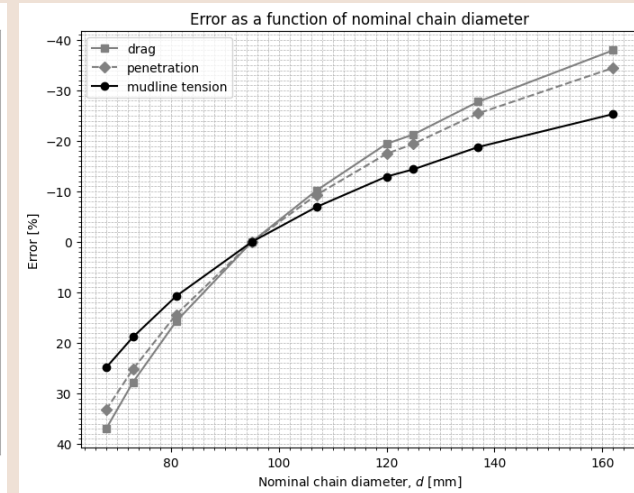
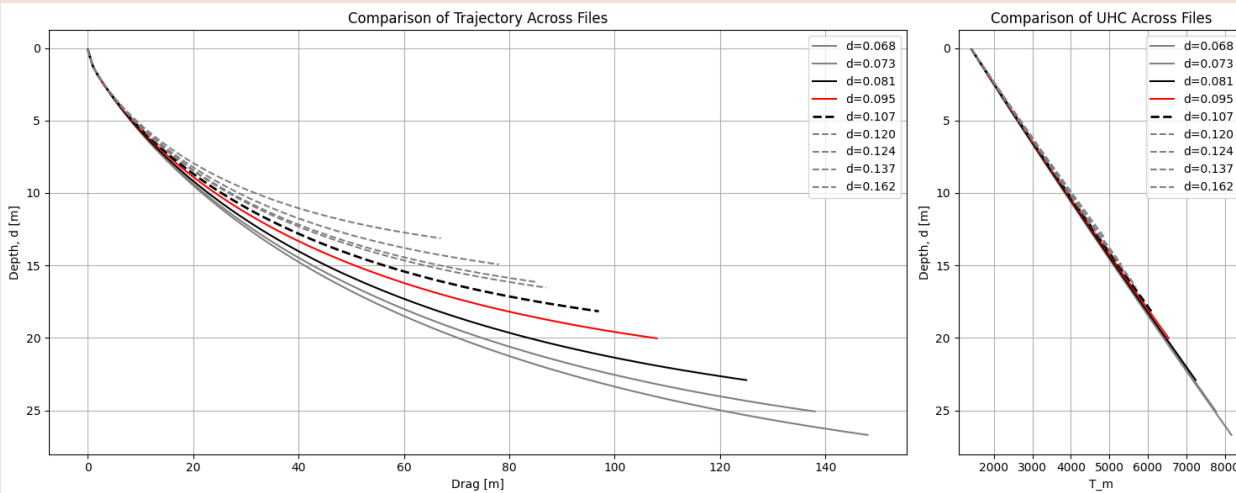
# Sensitivity of Projected Area, $A_p$

- › Relatively high sensitivity on UHC
- › Minor sensitivity on anchor trajectory
- › Sensitivity on form factor will be identical



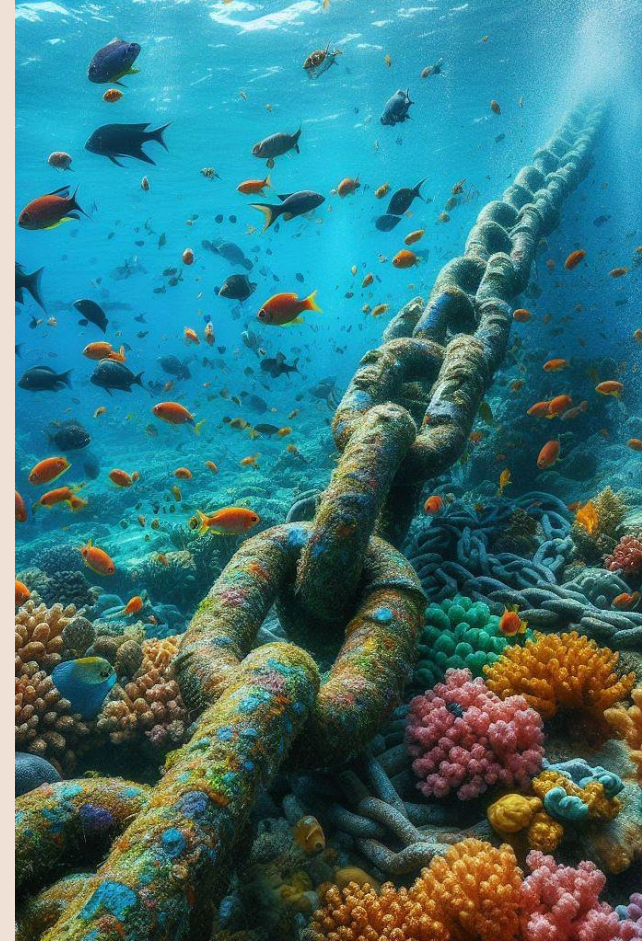
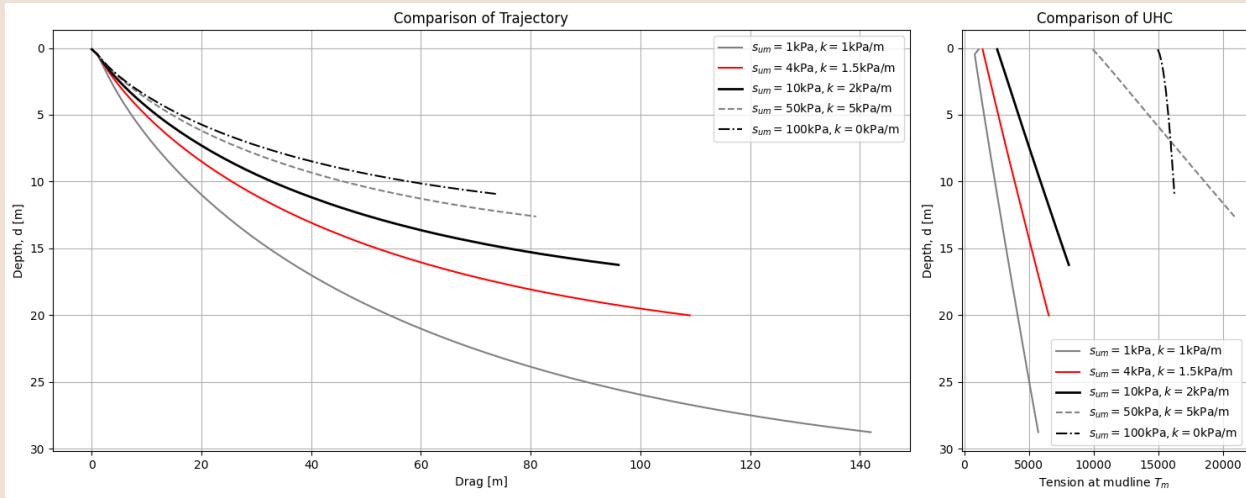
# Sensitivity of Embedded Chain Size

- › Selection of size of embedded chain is extremely important (also during calibration)
- › High effect on UHC (through penetration depth)
- › High effect on trajectory



# Site-Specific Soil Condition

- › Various soil conditions can be modelled
- › Calculations are considered more reliable when soil conditions are similar to the base case
- › Adjustability of the fluke-shank angle is not included (often 3 settings are found)



# Conclusions

- › Design Charts can form the basis for calibration of analytical tool
- › Assumption of initial fluke angle found insignificant
- › Important with proper calibration of form factor (and projected area)
- › Important with proper modelling of the embedded anchor line

## Limitations

- › The larger variation between site-conditions and calibration conditions, the larger uncertainties are expected.
- › Adjustable fluke-shank angle not included in the presented calibration
  - › Large fluke-shank angle beneficial for capacity. However, it may not be installable



Thank you