THE UNIVERSITY OF WESTERN AUSTRALIA
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The geotechnical performance of Deep Penetrating Anchors in calcareous sand

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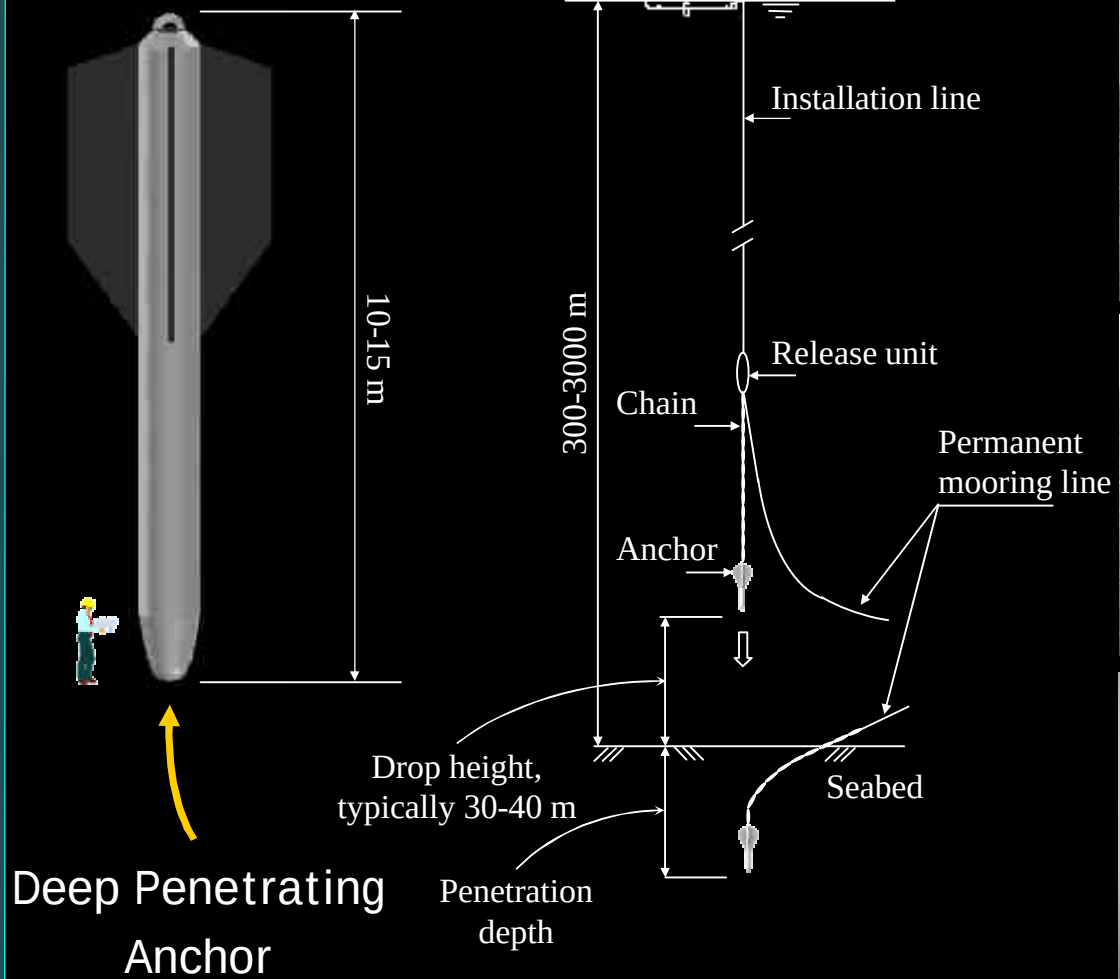
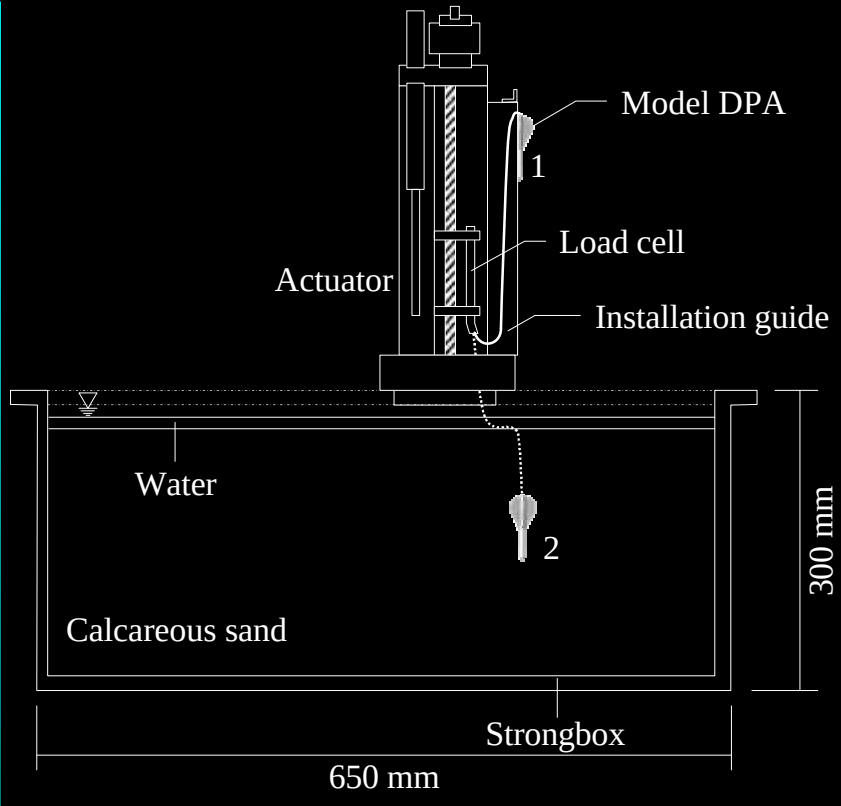
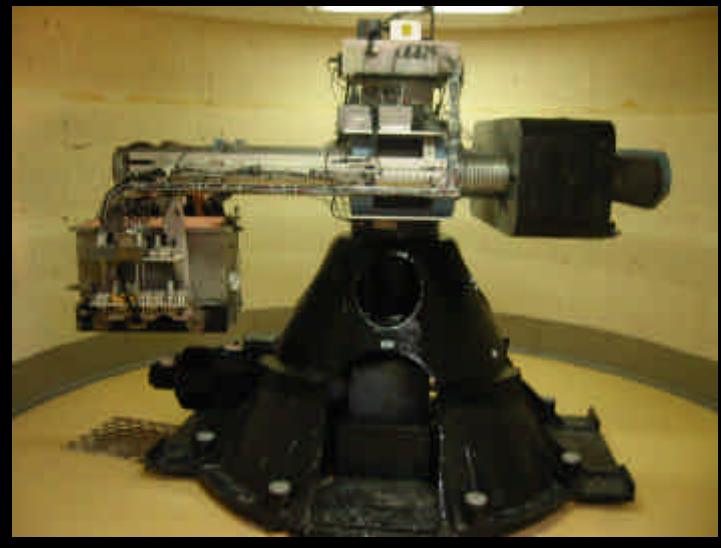

10-15 m
300-3000 m
Installation line
Release unit
Chain
Permanent mooring line
Anchor
Drop height, typically 30-40 m
Seabed
Penetration depth
Deep Penetrating Anchor



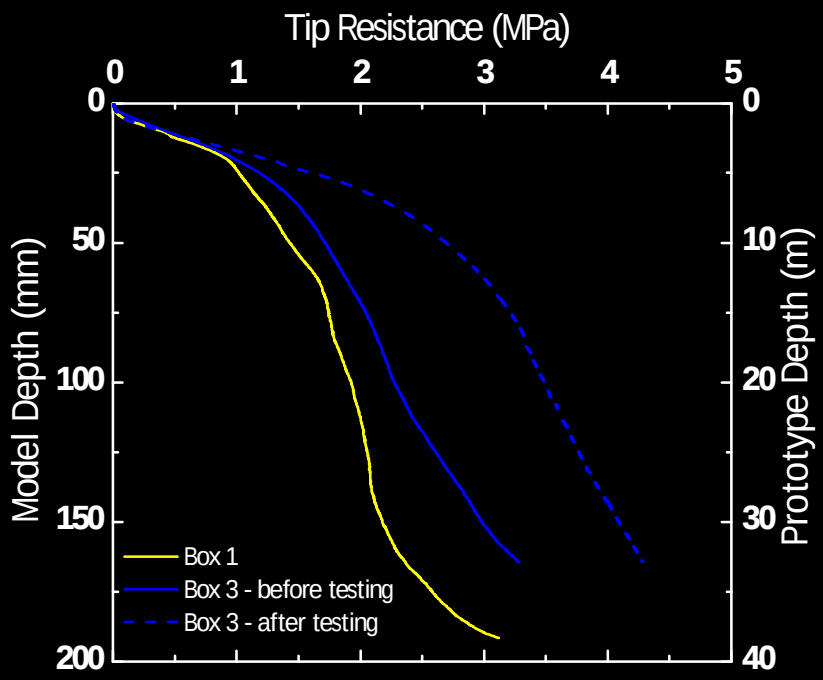


Beam centrifuge - 1.8 m diameter
200 kg capacity at 200 g

Tests conducted at 200 g

Model anchor:

D = 6 mm, L = 75 mm, m = 14.9 g



Sand recovered from seabed in vicinity of North Rankin platform

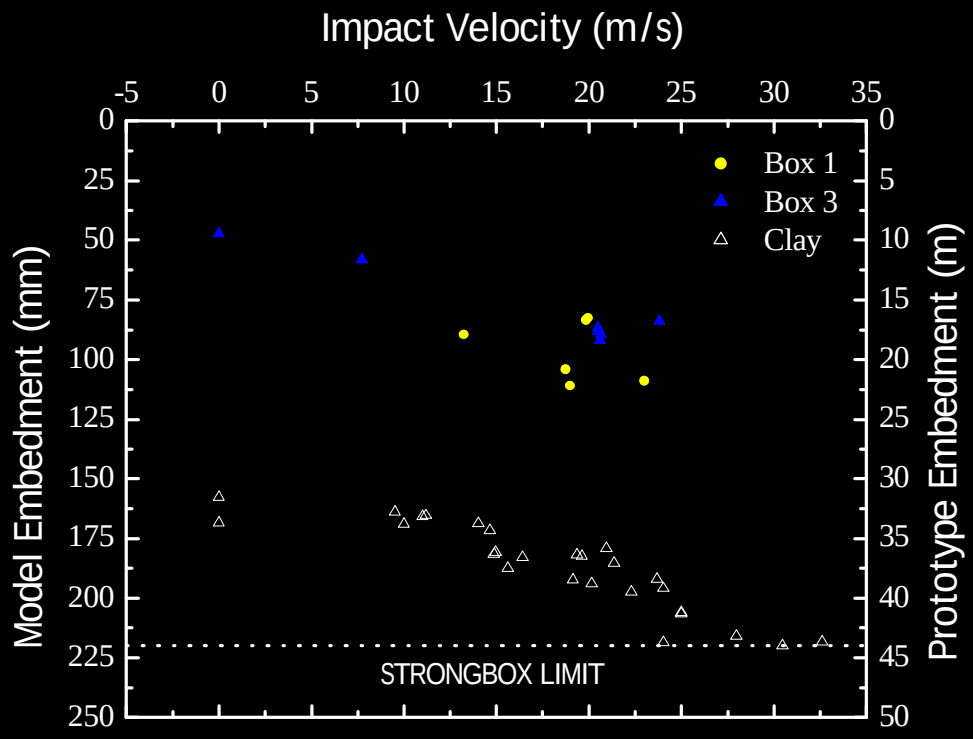
Sieved to max particle size of 0.3 mm

Saturated in centrifuge strongbox

Placed on vibrating table for ~ 1 hour

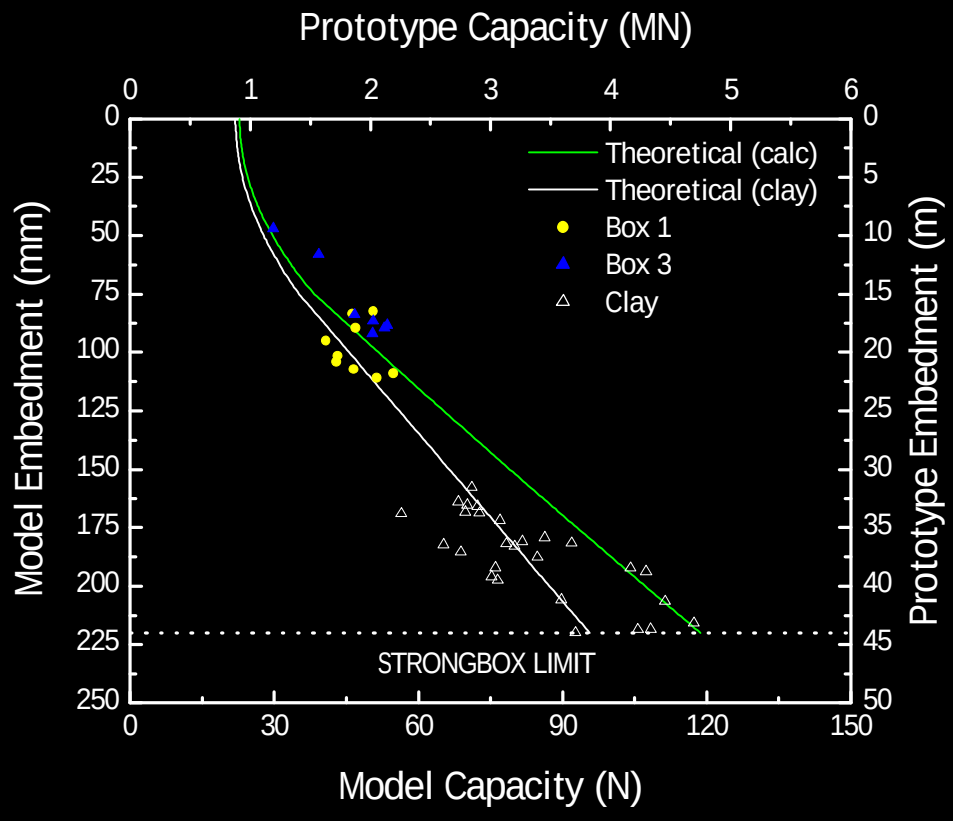
Strength increase during testing in Box 3 ? optimum strength & density condition after several ramp up/down cycles

Specific Gravity, G_s	Min. Dry Unit Weight (kN/m^3)	Max. Dry Unit Weight (kN/m^3)	Min. Void Ratio, e_{min}	Max. Void Ratio, e_{max}	Porosity, *n* (%)	Friction Angle, *f* (°)
2.73	7.5	10.1	1.65	2.59	62 – 72	40



At similar impact velocities embedment approximately 50% of that in normally consolidated clay ? 0.7 – 1.5 times anchor length

Good agreement with field data - embedment 1.25 times anchor length (Medeiros, 2001)



Theoretical vertical pullout capacity:

$$F_v = W_s + N_q s'_v A_p + b s'_v A_{shaft}$$

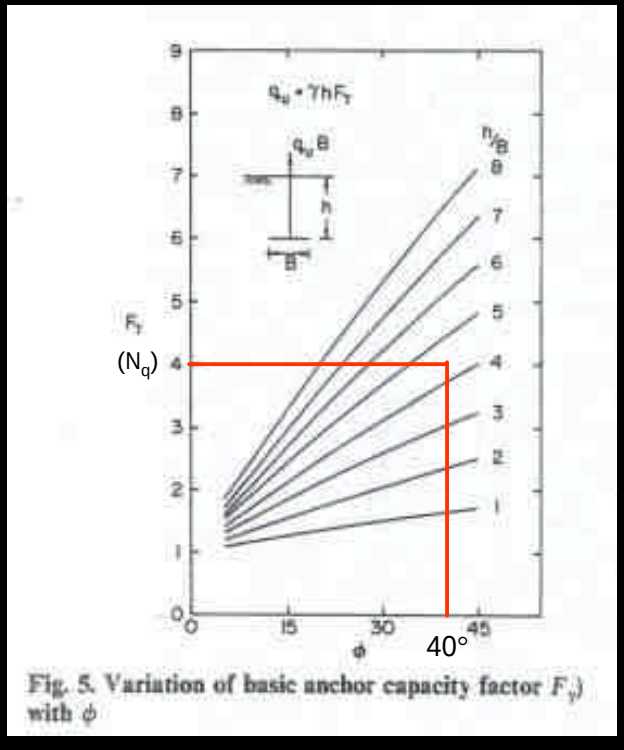
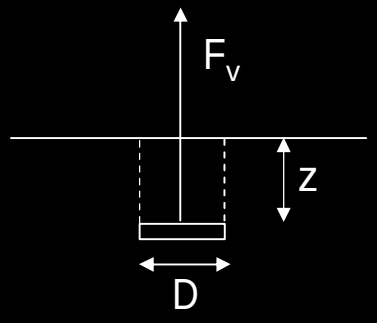
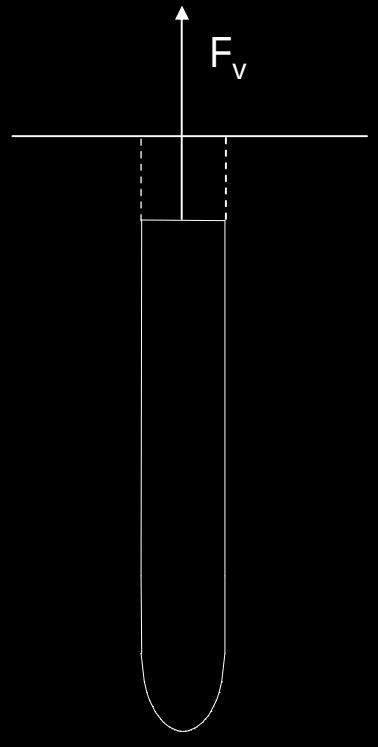


Fig. 5. Variation of basic anchor capacity factor F_γ with ϕ





Rowe & Davis (1982)

$$\frac{h}{B} \leq 8 \rightarrow N_q = 1 - 7$$

Model DPA

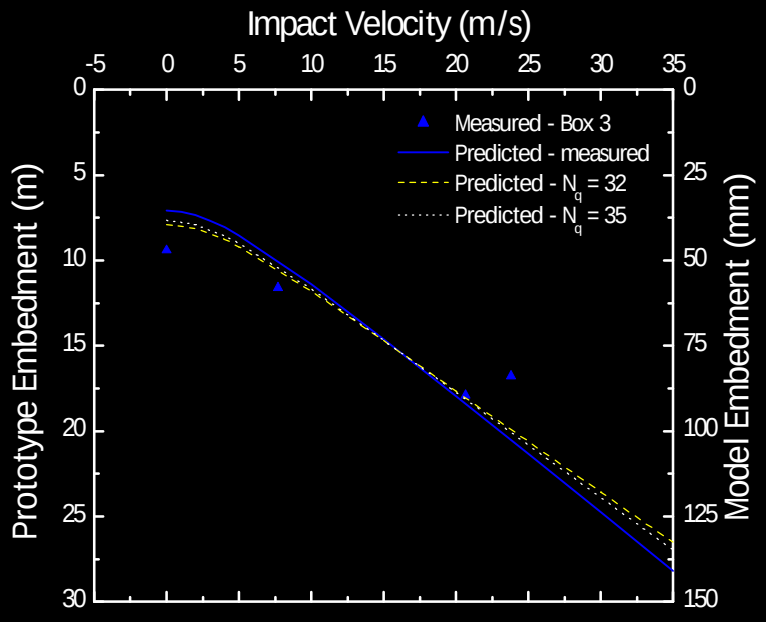
$$\left(\frac{z}{D}\right)_{padeye} \sim 4 \rightarrow N_q = 4$$

$$\Rightarrow \beta = 0.3$$

DPA padeye resembles vertically loaded plate anchor during pullout

β = 0.03 – 0.15 for driven piles at North Rankin (Randolph, 1988)

Cyclic degradation of shaft friction due to nature of pile installation (White & Lehane, 2004)



Static resistance profile

$$F_s = N_q s'_v A_p + b s'_v A_{shaft}$$

Anchor deceleration

$$m\frac{d^2z}{dt^2} = W_s - R_f F_s$$

Biscontin & Pestana, 2001

$$R_f = \left(1 + l \log \frac{v}{v_s}\right)$$

CPT tip resistance in Box 3 used to deduce average N_q = 32 ? ß = 0.42

Back analysis using ß = 0.3 (pullout) ? N_q = 35

? values back-calculated from measured embedments:

(i) Measured static resistance ⇒ ? ~ 0.6 %

(ii) Formulated static resistance ⇒ ? ~ 2 %

Clay ? ? = 5 – 20 %

>> CONCLUSIONS

- Prototype embedments of up to 1.5 times the anchor length were achieved with impact velocities approaching 24 m/s
- Good agreement with field test data ? 1.25 times anchor length
- Maximum vertical capacity of approximately 2 times the anchor dry weight
- Embedments and subsequent capacities in calcareous sand significantly less than those in normally consolidated clay at similar impact velocities
- Potential for higher embedments and capacities with higher impact velocities
- Possible to predict embedment depth of DPAs in calcareous sand from static resistance profile
- Low back-calculated ? values demonstrates minimal strain rate effects in calcareous sand
- DPA has potential for use as an anchoring system in calcareous sediments

THANK YOU