The Response of Segmentally-Lined Tunnels to Driving Piles in Sandy Soil

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1. Contextual Background

- ❑ Increased urbanisation often requires **pile foundations** for high-rise buildings and critical infrastructure.
- ❑ This could impact existing buried assets including underground **tunnels** (Fig. 1).
- ❑ Previous study showed that with a minimum clearance of **12.9** m between an existing tunnel and piles, the maximum horizontal movement of the tunnel reached **23.7** mm [1].
- ❑ The **influence** on existing tunnels during a driven pile installation has not received sufficient attention.

2. Aim and Objectives

- ❑ Better understand the impact of driven pile installation on segmentally lined tunnels.
- ❑ Develop a methodology incorporating **physical testing** and **numerical modelling**.
- ❑ Analyse tunnel **response** of tunnel by parametric study.
- ❑ Assess the current **guidelines** for driven pile installation.

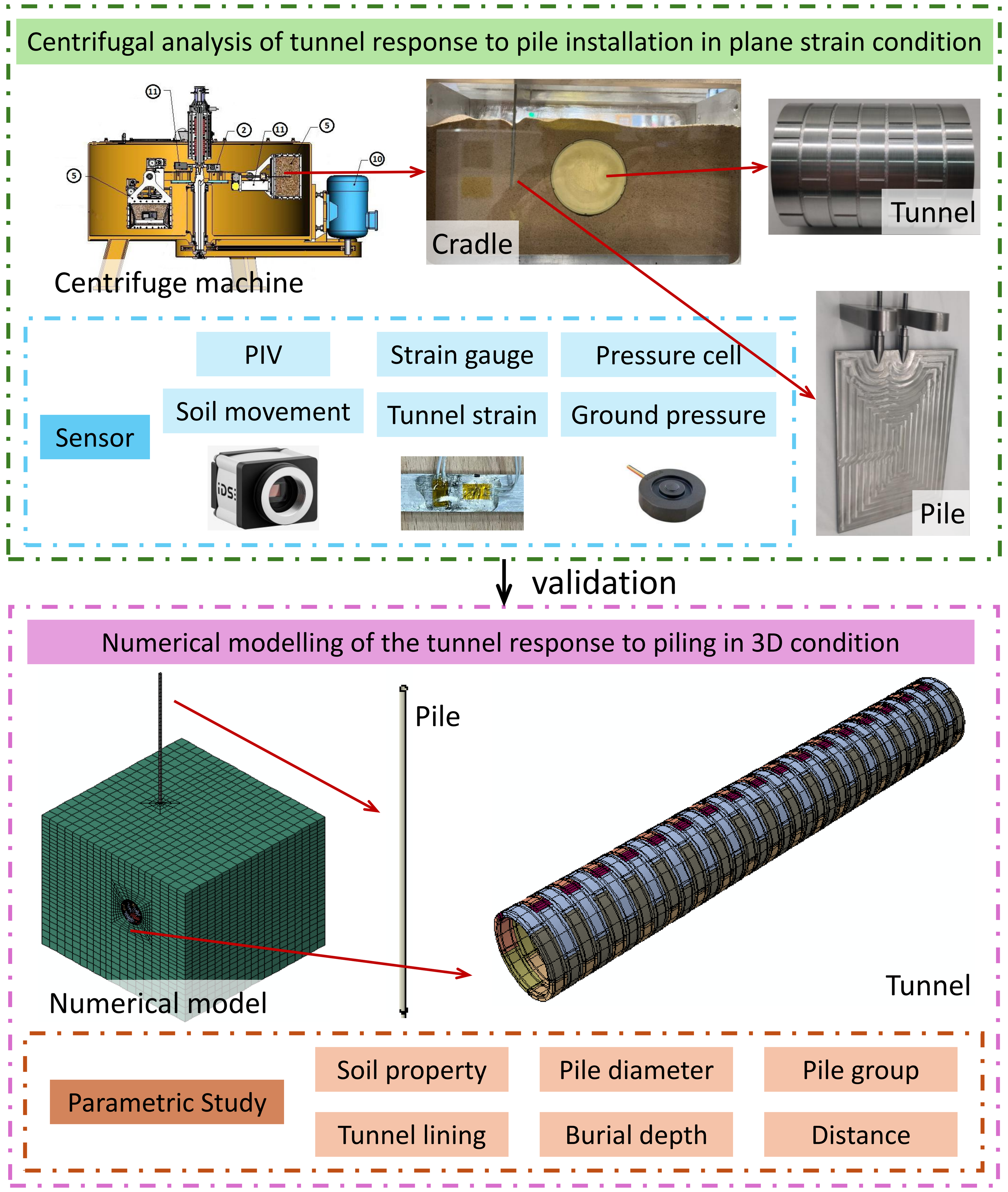
Fig. 1 Driving piles near existing segmentally lined tunnel (generated from OpenAI's ChatGPT) .

3. Methodology

- ❑ Development of physical test processes using a small geotechnical **centrifuge** with a diameter of 1.5 m with extensive sensing (strain gauges, load cells, PIV) to monitor the tunnel-pile interaction.
- ❑ The **segmentally** lined tunnel is designed based on the equivalent bending stiffness [2].

3. Methodology (continue)

- ❑ **Numerical modelling** considering more realistic conditions is validated where the pile installation is achieved using Arbitrary Lagrangian–Eulerian method [3].
- ❑ **Parametric study** is conducted to evaluate the influence of the variables the variables involved in tunnel-pile interaction.



5. What's next

- ❑ Physical modelling using a geotechnical **centrifuge** to simulate in-situ earth pressure conditions.
- ❑ Comparative analysis of tunnel behaviour with **continuous lining and segmental** lining to evaluate joint influence.
- ❑ Advanced numerical modelling for investigation of **key factors** affecting tunnel response under pile-driving-induced loads.

4. Results

- ❑ Case study is conducted where pile and tunnel are **0.6** m, **6.2** m in diameter and **9** m in clearance.
- ❑ Fig. 2 illustrates that the tunnel cross-section experiences **ovalisation** (timed by 100), which keeps **increasing** until penetration depth H is 19 m and then **decreases**.
- ❑ The peak of the maximum extension and contraction is **2.95 mm** and **-3.39 mm**, respectively.

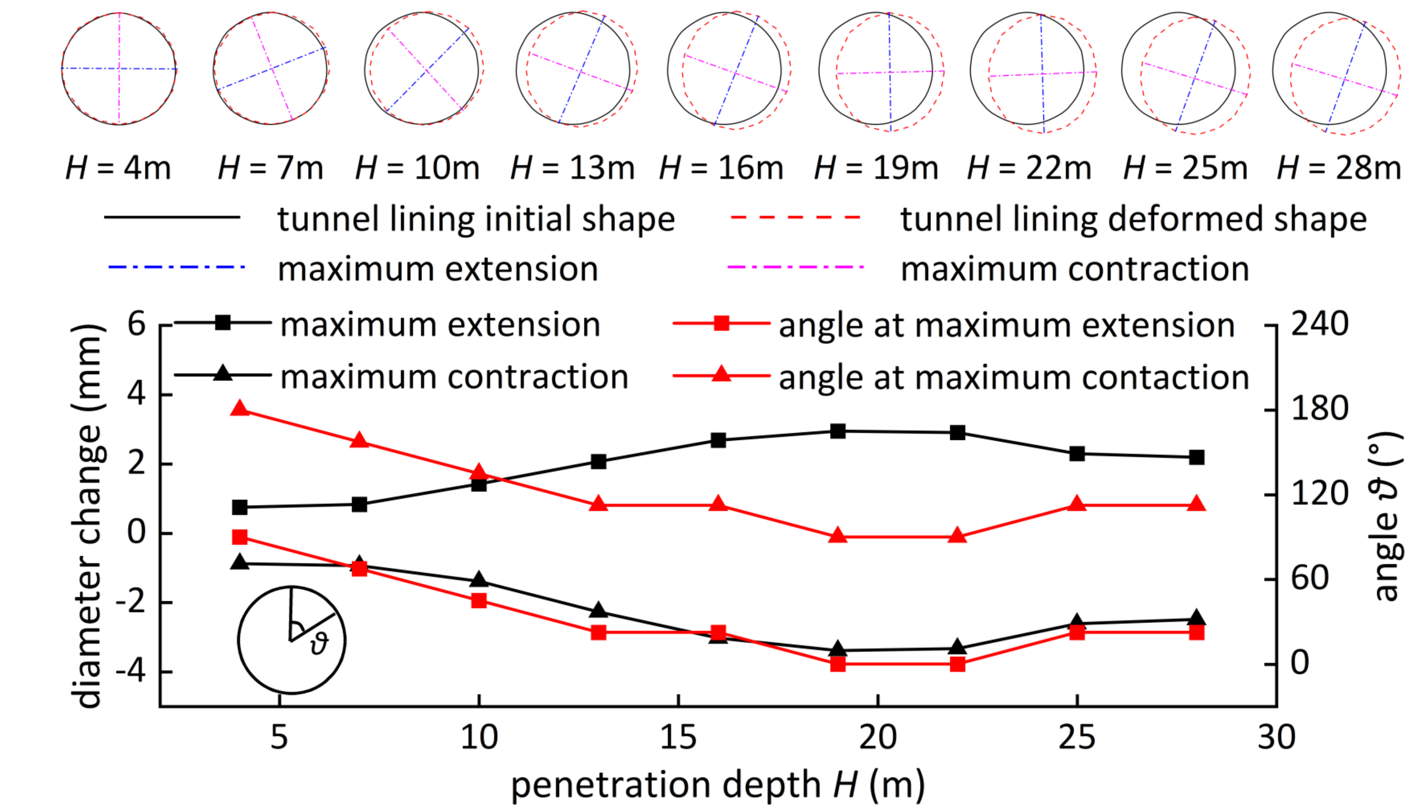


Fig. 2 Tunnel section deformation

- ❑ The tunnel exhibits consistent radial movement away from the pile, accompanied by settlement. Peak movements reach **9** mm (horizontal) and **3.9** mm (vertical) (Fig. 3 and Fig. 4 with H is the penetration depth).

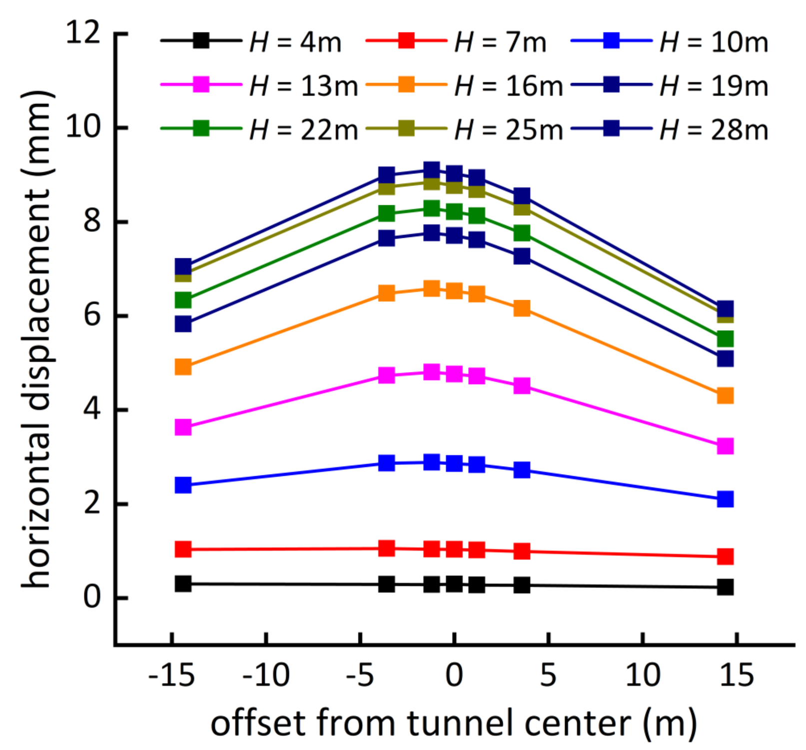


Fig. 3 Tunnel horizontal movement

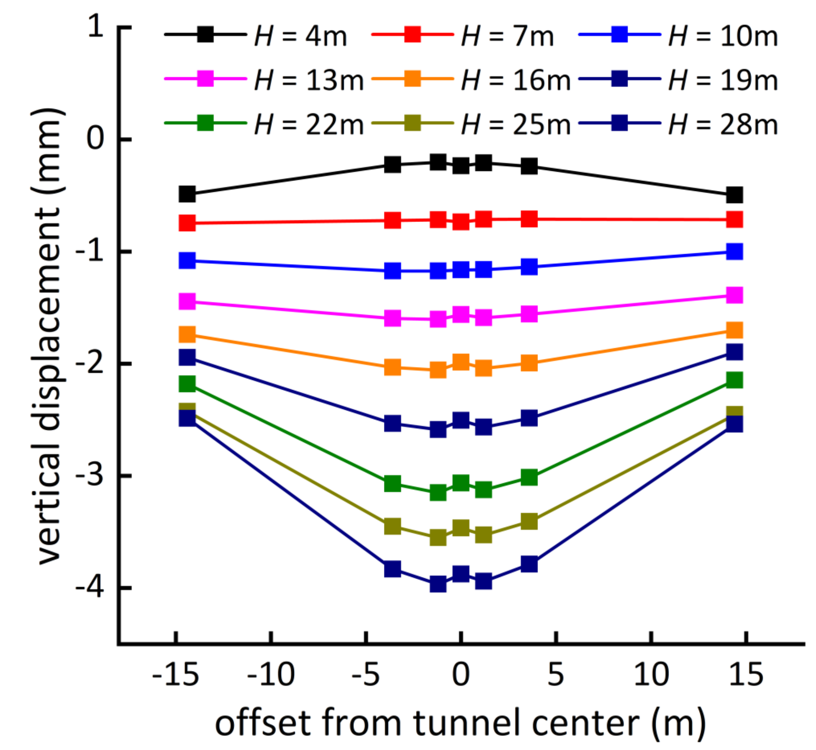


Fig. 4 Tunnel vertical movement

References

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[2] Fang, Q., Liu, X., Zeng, K., Zhang, X., Zhou, M., & Du, J. (2022). Centrifuge modelling of tunnelling below existing twin tunnels with different types of support. Underground Space (China), 7(6), 1125–1138.

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