Water Center for Latin America & the Caribbean
FUNDACIÓN FEMSA · TECNOLÓGICO DE MONTERREY · IDB

JOURNAL OF ZHEJIANG UNIVERSITY SCIENCE ABC

Cite this as: Sheng-liang Lu, Ning Zhang, Shui-long Shen, Annan Zhou, Hu-zhong Li, 2020. A deep-learning method for evaluating shaft resistance of the cast-in-site pile on reclaimed ground using field data. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 21(6):496-508. https://doi.org/10.1631/jzus.A1900544

A deep-learning method for evaluating shaft resistance of the cast-in-site pile on reclaimed ground using field data

Key words: intelligent approach, cast-in-site pile, shaft resistance, field test, reclaimed ground

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INTRODUCTIONS AND PROBLEMS

- Improvement of reclaimed ground is in high demand for infrastructure construction of cities in the offshore areas of China, which is characterised by a high water content, high compressibility, and poor mechanical properties.



Reclaimed ground

- The cast-in-site pile, one of the most popular techniques and features extensive reinforcement scope and an excellent improvement effect, relies on the shaft resistance from soils to provide support for buildings.



Cast-in-site piles

- The determination of the shaft resistance of a cast-in-site pile is mainly dependent on an empirical formulation or field tests, which can result in uncertainty for the pile design or prolong the construction.
- Most of current methods can be used only for ultimate shaft-resistance estimation based on field test results and the limit equilibrium theory
- In the present study, a new method called the long short-term memory (LSTM) deep-learning technique was employed to estimate the shaft resistance and axial force of cast-in-site piles.

METHOD

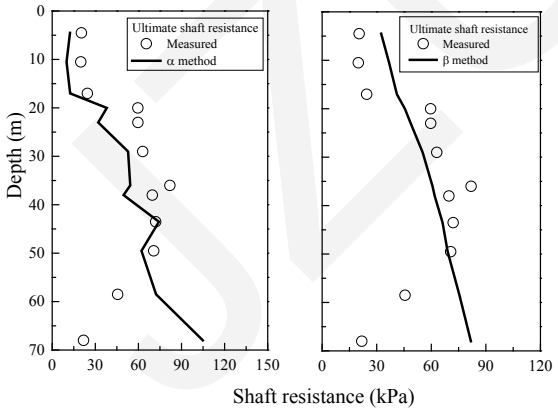
Shaft resistance of cast-in-site piles

Static loading test
- Soil properties
- layout of the tested piles
- static loading tests

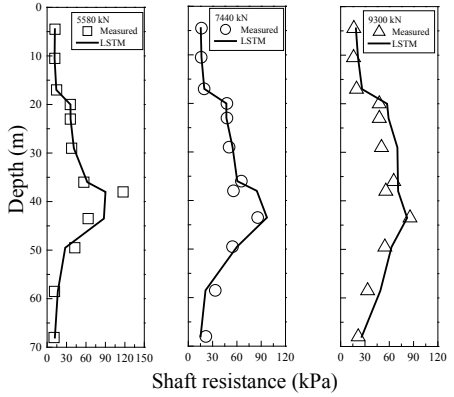
LSTM method
- Data preparation
- Architecture determination
- optimization

Empirical method
- undrained shear strength
- Coefficients calculation
- α method
- β method

comparison



Empirical method



LSTM method

RESULTS AND CONLUSIONS

- A series of field tests was performed to investigate the working states of the cast-in-site piles on the reclaimed ground. The cast-in-site piles bear the designed load on the reclaimed ground mainly through their shaft resistance. Most of the shaft resistance comes from the mid-dle of the piles. The thick marine mucky clay can only bear 10% of the load, owing to its poor me-chanical properties.

- The ultimate shaft resistance of the cast-in-site pile was assessed via empirical meth-ods. Generally, the empirical methods accurately estimated the ultimate shaft resistance of the middle of the pile. Larger biases of the estimated shaft resistance occurred at the top and end of the pile, indicating the limitation of the empirical methods for the reclaimed ground.

- The proposed intelligent approach based on the LSTM deep-learning technique predicted the axial force and shaft resistance with high accuracy not only in the ultimate bearing state of the pile but also in the normal working state. By learning the data for the normal working state, the LSTM model successfully predicted the ultimate shaft resistance under the ultimate bearing load.

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