Numerical Analysis on Bending Behavior of Precast Concrete Piles Using a Fiber Model

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Background

Piles could fail at surface level and in the deeper part, leading to pile strengthening or even worse, complete replacement of the pile. Seismic behavior of piles was studied on experiment conducted on different types of pile, such as: **Steel-encased Concrete Piles (SC), Pre-stressed Reinforced Concrete Piles (PRC),** and **Pre-stressed High-Strength Concrete Piles (PHC)** as shown in **Fig 1**. In this research, bending behavior of SC and PRC piles was observed and compared to a fiber model created using software called OpenSees, Open System for Earthquake Engineering Simulation.

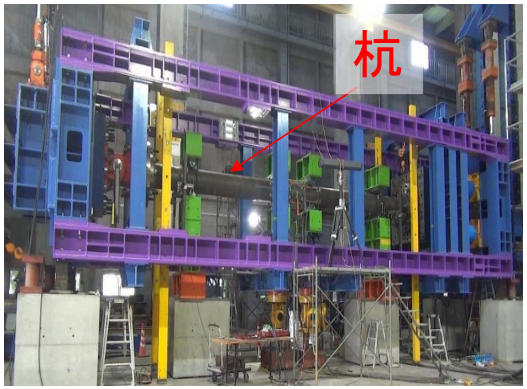


Fig 1 Pile test facility at BRI, Tsukuba

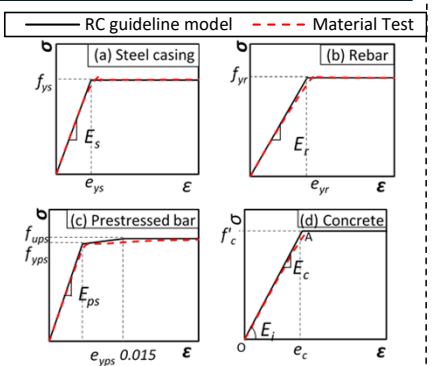
Research Objectives

To Analyze and verify the tested **SC** and **PRC** piles using a fiber model,

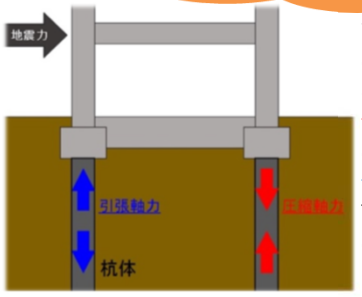
- ☐ **Verify the bilinear concrete model capability in predicting pile's load (Q) – drift ratio (R) relationship.**
- ☐ **Study the curvature distribution along pile length.**

Curvature (曲率) is the structure's ability to deform from it's original form.

Material Model

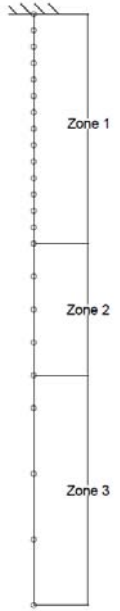


What happened to piles when big earthquakes happen?

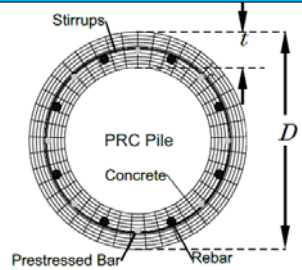


When big earthquakes occur, one side of the pile will experience compression axial force (圧縮軸力) while the other side will experience tensile axial force (引張軸力). This phenomenon occurs in a cyclic manner, which causes major damage to piles.

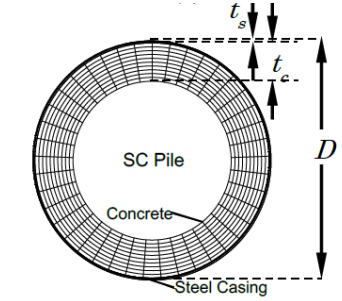
Description of Fiber Model



2(a)
Line diagram of Cantilever PIle



2(b)
Cross section of fiber model for PRC (プレストレストコンクリート杭)



2(c)
Cross section of fiber model for SC piles (鋼管コンクリート杭)

Figure 2(a) – 2(c) represents the section analysis model (断面解析) used to produce the results

Results

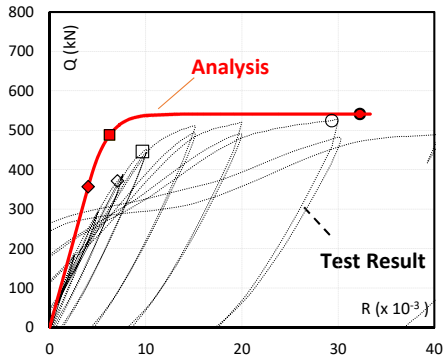


Fig 3 Q-R Relationship

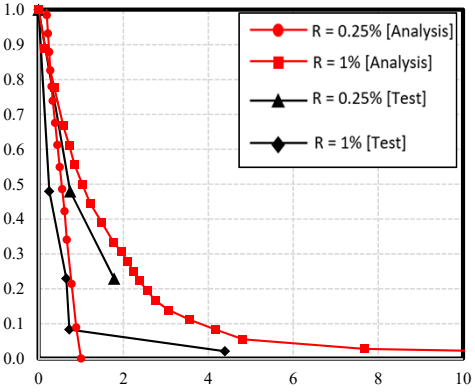


Fig 4 Curvature Distribution

Conclusions

- Bilinear concrete model used in the numerical analysis was able to capture important characteristics of Load (Q) – Drift Ratio (R) curve accurately for both SC and PRC piles.
- From curvature distribution, it is seen that damage spreading at particular drift does not depend on the amount of load applied to the specimen.
- Future works are required on different concrete model other than Bilinear, since Bilinear did not capture the concrete's post-peak behavior accurately

Contribution to Society

This research on pile behavior is aimed to create a rational and economical basis on seismic design method of pile foundations and will provide safety living environment in earthquake-prone area.