Shear Damage Evaluation of Prestressed High Strength Concrete Piles using Finite Element Program

Author: Yopi Prabowo O., Advisor: Prof. Susumu Kono, Tokyo Institute of Technology

Background

Based on reports of the 2011 Great East Japan Earthquake, sub-structure damage (**杭及び杭頭の損傷**) (Fig 1)is considered as one of the most severe observed damage which is worse than that of the upper-structure damage (**上部構造の損傷**). The improvements regarding the sub-structure system including creating a precast high strength concrete (PHC) pile of various sizes. Three pile specimens were created in order to observe the shear performance of PHC pile under various axial load ratio (**様々な軸力比**). The finite element model of the three piles were analyzed.

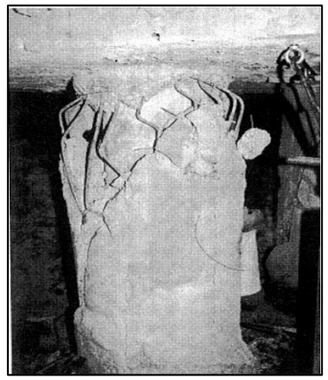


Fig 1 Pile damage after 2011 Great East Japan Earthquake

Objectives

Validate the shear failure experiment of PHC pile using finite element model in case of load-drift ratio relationship ,strain contour and crack propagation. Observe the behavior of the PHC pile under various axial load.

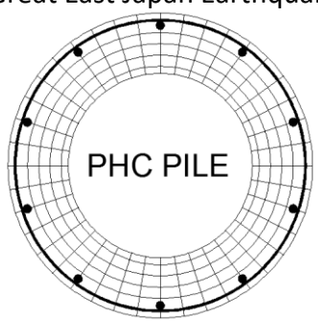
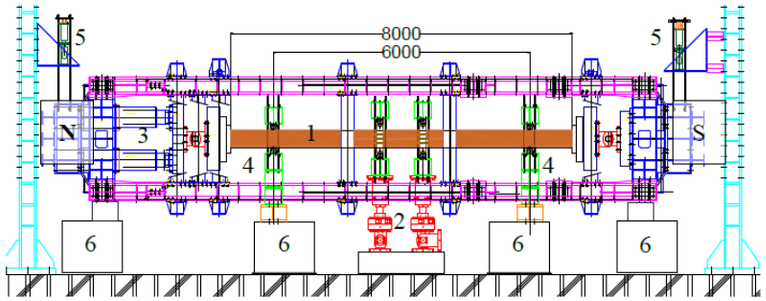


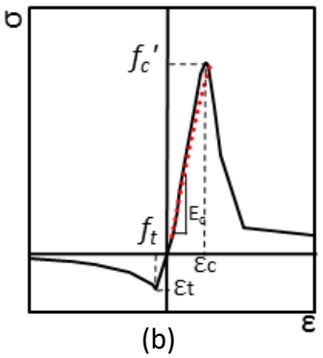
Fig 2 Pile section

Model Description

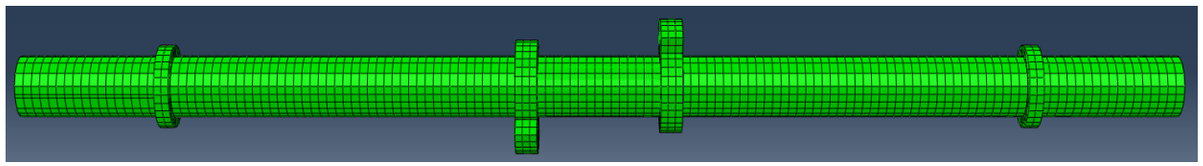
The finite element model (有限要素モデル) was created based on the shear experiment of 3 PHC pile specimens conducted in the Building Research Institute (建築研究所) at Tsukuba (fig 3(a). The concrete compressive strength (圧縮応力) used in this pile model ranges from 114 – 117 Mpa. The red dotted line shows the result from concrete compression test while the black line is the material model used in the program. The result of this formulation is shown in Fig 3(c) where a finite element model of the pile specimen is created and compared.



(a)



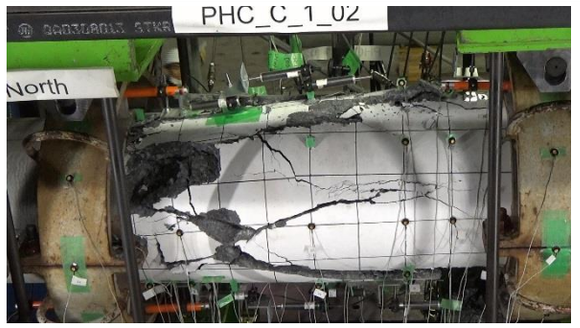
(b)



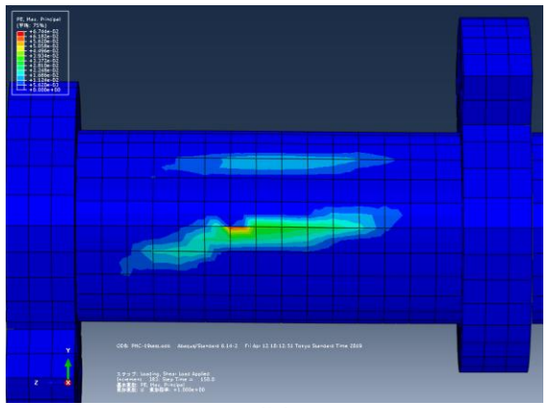
(c)

Fig. 3(a) Pile loading system at Building Research Institute, (b) Concrete material model and (c) Finite Element Model of the same pile specimen

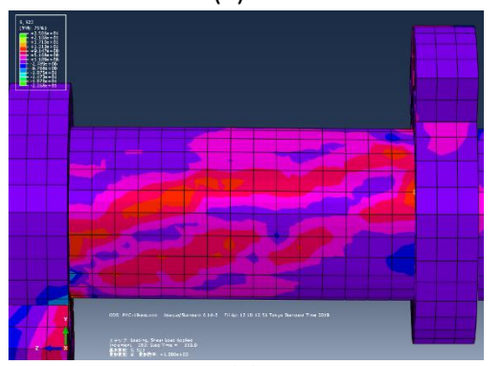
Results



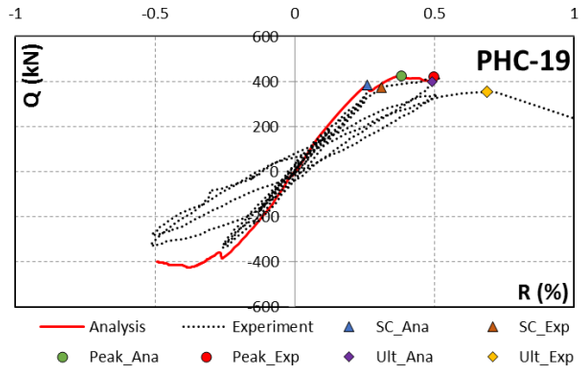
(a)



(b)



(c)



(d)

Fig. 4(a) pile footage at end of experiment, (b) plastic strain contour, (c) stress contour at end of analysis and (d) load-drift ratio relationship of PHC pile

As can be seen from Fig 4(b), the strain contour could be equivalently compared to the results from experiment (Fig 4(a)) where extensive damage could be observed at center of the pile specimen. Due to high strength concrete, the specimen fails explosively.

Conclusions

The analysis result from finite element model agrees relatively well with the result from experiment on the strain contour and load – drift ratio relationship.

Contribution to Society

This research contributes on providing recommendation to the design criteria of pile members provided by Architecture Institute of Japan (日本建築学会)in order to build sustainable living environment (持続可能的な生活)