Experimental investigation on flexural behavior of cast-in-place concrete-filled steel tube piles with large D/t under large axial loads

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Background

Pile foundation were highly damaged during recent earthquakes leading to the strengthening or complete replacement of the building. As the damage of piles during earthquake hampers the functionality and structural health of whole building, they should be designed considering large axial loads and bending moments that occurs during earthquake.

Fig.1: Damage to precast piles during 2016 Kumamoto Earthquake (photo courtesy : Prof. Osamu Kaneko)

Purpose

In Japan, CFST piles are used near pile-pile cap connection of mid-to high rise building to resist high shear force and deformation demands during strong earthquakes. These piles have large diameter (600-2500mm) ,large D/t ratio (52-200) and subjected to high axial load (up to 0.4). However, existing experimental studies do not represent CFST piles of large diameter with thin tubes under high axial load used in design practice.

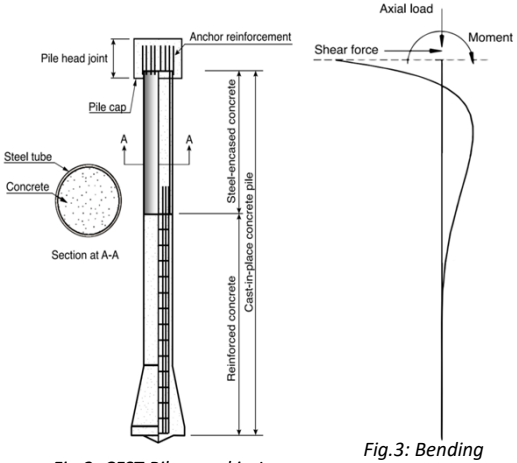

Fig.2: CFST Piles used in Japan

Fig.3: Bending moment distribution

Results

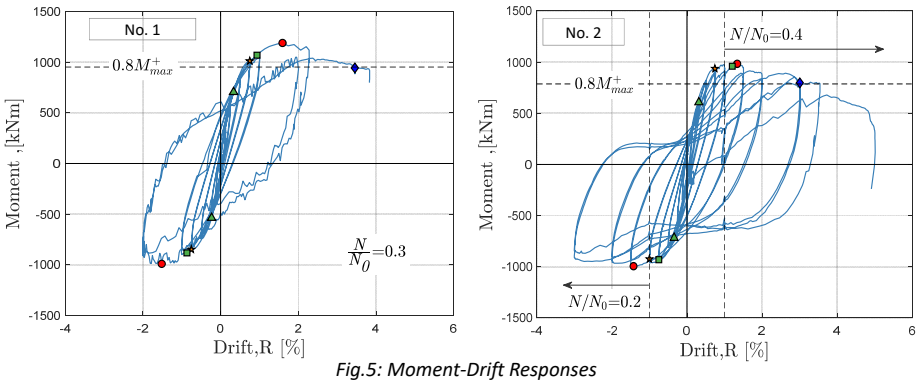

Fig.5: Moment-Drift Responses

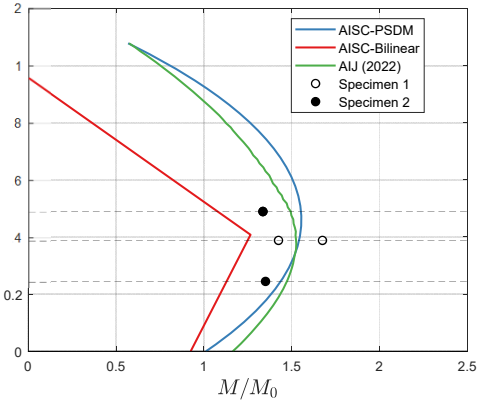

Fig.6: N-M interaction diagram with three methods.
**PSDM: Plastic Stress Distribution Method*

Conclusions

- Damage in CFST piles occurred in the sequence of tube yielding, local buckling, and reduction in lateral load-carrying capacity. Local buckling of the tube did not result in the immediate failure of the piles. Moreover, the piles retained axial load-carrying capacity until the end of loading.
- For the tested specimens (D/t=133), the plastic stress distribution method of AISC-360 and strain compatibility method of AIJ guidelines both gave unsafe estimates of the moment capacity obtained from the experiment. In contrast, the bilinear interaction method of AISC-360 produced a conservative estimate of moment capacity.

Specimen Details & Experimental Program

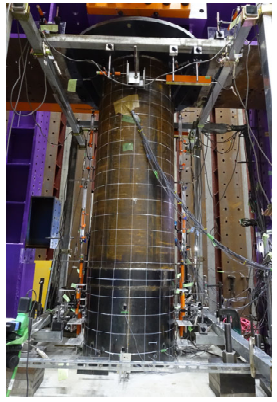

Fig.3: Concrete-filled steel tube pile specimen

Test variable

Specimen	N/N_0
No.1	0.3
No.2	0.2~0.4

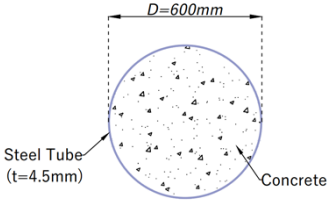

Fig.3: Cross Section

Fig.4: Loading Setup

Social Impact

This research aims to provide recommendation to improve the design criteria of CFST piles and contribute to resilient build environment.