Numerical analysis to evaluate ultimate flexural performance of precast concrete piles subjected to tensile or high compressive axial load.

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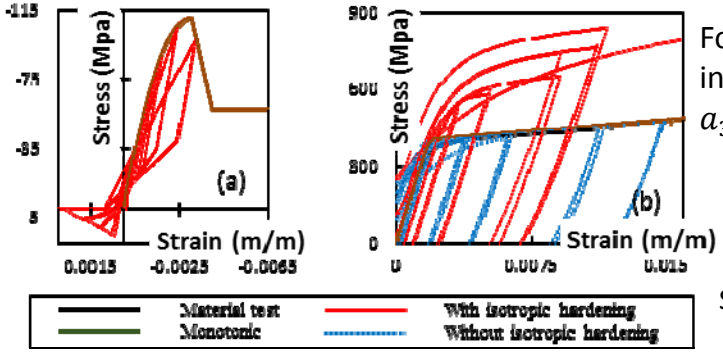
Purpose of Research

AIM: To establish a reliable modeling technique to analyze flexural cyclic behavior of SC piles.

OBJECTIVE: To numerically analyze test piles using a fiber-based model to simulate moment-curvature relationships.

- predict behaviors beyond ultimate deformation capacity.
- simulate characteristics of hysteresis loop.

Material Model



For isotropic hardening in steel,
$a_3 = 0.3^*$, $a_4 = 1^*$.

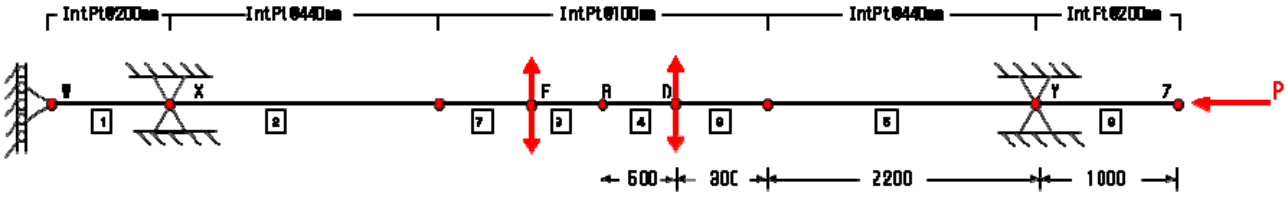
$$\frac{\sigma_{st}}{\sigma_y} = a_3\left(\frac{\varepsilon_{max}}{\varepsilon_y} - a_4\right)$$

*Calibrated against SC_2 pile.

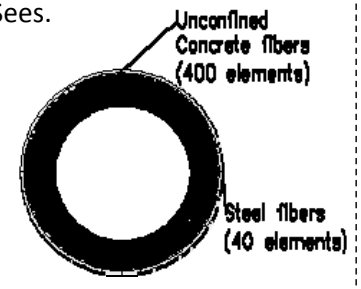
(a) **Kent-Scott-Park** model with linear tension softening for concrete.
(b) **Giuffré-Menegotto-Pinto** model with isotropic strain hardening for steel.

Finite Element Model

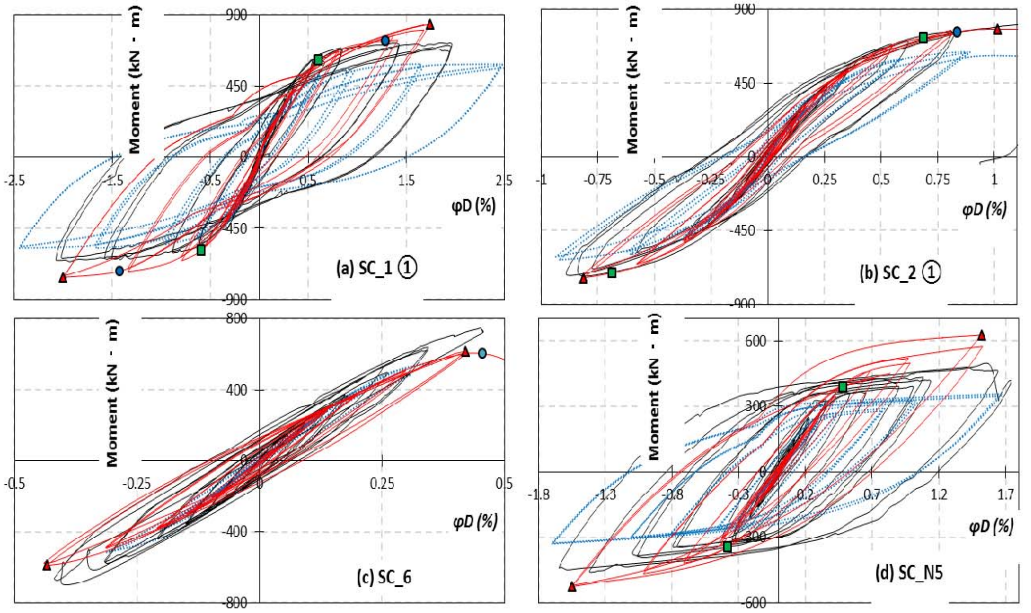
6 SC piles were analyzed using a fiber section analysis with force based beam-column elements using OpenSees.



Line diagram and cross section of fiber-based finite element model for **SC_1 pile**



Results



*Analytical results for **SC_6** pile are shown up to **φ D(%) = 0.35%** for the case of no isotropic hardening, as convergence was not obtained for larger drifts.

Test
Steel casing tensile yield
Without isotropic hardening
Steel casing compressive yield
With isotropic hardening
Maximum moment

Conclusions

- Steel model WITHOUT ISOTROPIC HARDENING resulted in an underestimation of maximum moment capacity, with an error of about 20%.
- Steel model WITH ISOTROPIC HARDENING in tension and compression , calibrated for SC_2 pile, resulted in reduction in overall error to about 6%.
- With proper adjustment of isotropic hardening parameters better estimations of moment capacity of piles can be achieved.