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Geo-Structural Nonlinear Analysis of Piles for Performance Based Design

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Pile foundations supporting bridge structures are often subjected to static and/or dynamic lateral loads due to different hazards such as vessel impacts, traffic, waves, wind, and earthquakes. Two major factors that affect the pile lateral behavior under extreme lateral loading are the interaction between the pile and surrounding soil and the material inelasticity of the pile itself. This presentation covers the state-of-the-art of modeling the nonlinear response of piles. In addition, it describes the recent development of an efficient and robust approach for the analysis of piles based on the Beam on Nonlinear Winkler (BNWF). In this work, a general cyclic BNWF model is developed to account for the important features of soil-pile interaction problem including lateral load characteristics, soil cave-in, soil-pile side shear, gap formation, and strength and stiffness hardening/degradation. The inelastic behavior of pile material is also modeled effectively by implementing the advanced fiber technique. The capability of the developed model in predicting the response of pile under lateral static and cyclic loading is validated by comparing the computed results with experimental data.