Nonlinear responses of energy storage pile foundations with fiber reinforced concrete

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Abstract

A renewable energy storage pile foundation system is being developed through a multi-disciplinary research project. This system intends to use reinforced concrete pile foundations configured with hollowed sections to store renewable energy generated from solar panels attached to building structures in the form of compressed air. However, previous research indicates that the compressed air will generate considerable high circumferential tensile stresses in the concrete pile, which requires unrealistic high hoop reinforcement ratio to avoid leakage of the compressed air. One possible solution is to utilize fiber reinforced concrete instead of placing the hoop reinforcement to resist the tensile stress. This paper investigates nonlinear structural responses and post-cracking behavior of the fiber reinforced concrete pile subjected to high air pressure through nonlinear finite element simulations. Concrete damage plasticity models were used in the simulation. Several parameters were considered in the study including concrete grade, fiber content, and thickness of the pile section. The air pressures which the pile can resist at different crack depths along the pile section were identified. Design recommendations were provided for the energy storage pile foundation using the fiber reinforced concrete.

Keywords

fiber reinforced concrete; pile foundation; nonlinear structural responses; compressed air; renewable energy storage

References

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