ICCES, 2023, vol. 27, no.4
DOI: 10.32604/icces.2023.09077

PROCEEDINGS

Experimental and Numerical Simulation Study on Axial Drop Hammer Impact of Rubber Modified Non-Autoclaved Concrete Pipe Pile

Sheng Lan[1] and Fei Yang[1,*]

[1]School of Civil and Transportation Engineering, Guangdong University of Technology, Guangzhou, 510006, China
*Corresponding Author: Feng Liu. Email: Fliu@gdut.edu.cn

ABSTRACT

Non-autoclaved concrete pipe piles are gaining attention as an environmentally friendly alternative to autoclaved concrete pipe piles. The purpose of this study was to investigate the changes in the impact resistance of a non-autoclaved concrete pipe pile with the addition of rubber. To this end, various volume fractions of rubber particles were used to replace the fine sand in the non-autoclaved pipe pile concrete (0%, 5%, 10% and 15%). Additionally, the axial impact resistance of rubber modified non-autoclaved concrete pipe pile was studied from the concrete materials and pipe pile components through quasi-static, dynamic compression and splitting tensile tests and large drop hammer impact tests. And the crack propagation characteristics of pipe pile with cracks under the impact of drop hammer were explored based on experiments and numerical simulation methods. The results showed that (1) after adding rubber particles, the tensile-compression ratio of the rubber-modified non-autoclaved pipe pile concrete increased with the rubber content, and the brittleness index of concrete decreased. (2) Under the premise of satisfying the strength requirements of prestressed high-strength pipe pile concrete, the impact toughness index and energy consumption ratio of the non-autoclaved pipe pile concrete were the largest when the rubber content was 10%, which were 52.2% and 51.2% higher than those without rubber particles, respectively. (3) When the impact energy of the drop hammer is less than 40kJ, neither the autoclaved concrete pipe pile nor the non-autoclaved concrete pipe pile has cracks. When the impact energy of the drop hammer is greater than 58kJ, the end of the non-autoclaved concrete pipe pile is damaged. (4) After adding rubber particles, the energy absorption capacity and crack resistance of non-autoclaved concrete pipe pile are improved. (5) The non-autoclaved pipe pile is prone to tensile and shear failure under the impact of drop hammer due to the synergetic effect of up traveling wave and down traveling wave. (6) When there is an initial crack in the non-autoclaved pipe pile, the tensile stress at both ends of the crack increases with the increase of the included angle between the crack direction and the impact direction of the drop hammer, and the crack is easier to expand. When the included angle between the two is 90 °, the tensile stress at both ends of the initial crack is maximum, and the crack initiation and expansion time is short. In practical projects, the use of pipe piles with such initial cracks should be avoided.

KEYWORDS

Non-autoclaved concrete pipe pile; falling hammer impact; rubber particles; crack propagation; impact toughness

Funding Statement: The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.