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A THREE-DIMENSIONAL SEMI-ANALYTICAL MODEL FOR PREDICTING OFFSHORE PILE DRIVING NOISE

Qingpeng Deng [1, 2], *Weikang Jiang [1], Mingyi Tan [2], Jing Tang Xing [2]

[1] Institute of Vibration, Shock & Noise, Shanghai Jiao Tong University, 200240, China,
email:wkjiang@sjtu.edu.cn,
http://wkjiang.sjtu.edu.cn/EnglishWeb

[2] Fluid Structure Interactions Group, Faculty of Engineering and the Environment, University of Southampton, SO17 1BJ, UK
email:M.Tan@soton.ac.uk
http://www.southampton.ac.uk/engineering/about/staff/mingyi.page

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Abstract. It radiates high level of wideband underwater noise to drive large tubular piles into the seafloor by hydraulic impact hammers, which may detrimentally impact both fishes and marine mammals, such as dolphins and whales. Noise prediction and reduction are necessary in underwater engineering in order to protect marine animals. This study develops a three-dimensional semi-analytical method, in which the pile is modeled as a thin elastic cylindrical shell, to predict vibrations and underwater acoustic radiations caused by hammer impacts. A modified variational functional based on the Reissner-Naghdi's thin shell theory is proposed to generate the mathematical equations governing the pile-water interactions. The shell is divided into several segments in axial direction, and the sound pressures in both exterior and interior fluid fields are expressed in an analytical series in frequency domain. The soil is modeled as uncoupled springs and dashpots distributed in three directions. The effect of fluid and soil on the pile is taken into consideration by incorporating their virtual works into the variation of the functional. The underwater sound responses in both frequency domain and time domain are obtained. The mechanical model can be used to estimate underwater noise of piling and explore potential noise reduction measures to protect marine animals