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THE MAGNETIC RESPONSE OF A FERROMAGNETIC CYLINDER SUBJECTED TO IMPACT INDUCED STRESS WAVES

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Increasing demand for energy from renewable sources, has resulted in a spectacular grow in the number of offshore wind farms in the North Sea. Wind turbines in these parks are mounted on top steel monopiles with diameters ranging up to eight meters. In most cases, these thin-walled cylindrical piles are driven into the seabed by hydraulic impact hammers. Due to the large forces exerted at the pile head during pile driving, the structure is prone to plastic deformations. Classical strain measurement techniques are difficult to employ at the pile head during pile driving, therefore a non-collocated method to assess the state of the pile material is desired. In this paper the possibility of using the magnetic field generated by the magnetisation of the ferromagnetic pile to assess the stress state is explored. Experiments have shown that the magnetisation of a ferromagnetic material changes with the applied stress level [1, 3], even in weak constant magnetic fields, like the one of the Earth. Recently, experiments on the magnetic response of a large-scale ferromagnetic thin-walled cylinder under stress were reported by Viana et al. [4]. The loading, however, was quasi-static, whereas for impact loading the time scales involved are in the order of milliseconds. A numerical model is developed which couples the magnetomechanical model of Jiles [2] to the propagation of mechanical stress waves in the pile. The resulting magnetic field in the air region surrounding the pile is compared to the stress history to show the applicability of the model to asses the stress state due to impact loading.

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