New digital method could help quantify the damage on buildings and wind turbines after major storms

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Credit: Jem Sanchez from Pexels

New research shows a new digital method could be the key to understanding how structures, such as buildings, behave when they are

damaged.

A new two-stage method, published in *Mechanical Systems and Signal Processing*, explains how engineers can develop computer models that simulate the structural behavior which can be used to quantify damage that might exist on real structures.

Many structures such as buildings, bridges, and offshore wind turbines are supported on foundation piles, which connect the structure to the ground and help to support it against loads that the structure might experience.

In many cases, the exact properties of these piles might be unknown, such as the length they are embedded, or the stiffness (support) that the soil provides to them.

Dr. Luke J Prendergast and Andreas Ioakim, from the University of Nottingham Faculty of Engineering, developed a method that can estimate the embedded length of piles by simply applying a hammer impact to the top of the pile, and measuring the resulting vibrations.

A single hammer impact applied to the pile causes the pile to vibrate, and these vibrations can be measured by a simple sensor placed on the structure. The information from the hammer impact force and the sensor vibration can be used to estimate the embedded length of the pile through a method that creates a virtual model of the pile.

The method has the potential to be used in the offshore wind turbine industry, where creating digital twins of individual turbines is very important for understanding if they are damaged before and after major storms.

"The method is a positive step in the field towards enabling the creation

of digital twins of our built infrastructure for the purpose of damage detection and extending the lifetime of our structures," says Dr. Prendergast.

"The first step in developing digital twins or virtual models of structures relies on knowing the geometry and constraints, and this approach can estimate the embedded lengths of foundation piles and the stiffness properties of the soil from a simple impact test. It has the potential to help engineers understand the current condition of structural foundations so that virtual models can be created."

More information: A. Ioakim et al, A two-stage method to estimate the embedded length of foundation piles using FRF-based model updating, *Mechanical Systems and Signal Processing* (2024). DOI: 10.1016/j.ymssp.2024.111603

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