DRISI
Caltrans Division of Research,
Innovation and System Information

Research Results

Mitigating Acoustic Impact of Driving Underwater Piles

A double-walled steel tube can reduce the underwater sound level up to 10 decibels and the effect on aquatic life

Environmental

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Project Title:
Structural Acoustic Analysis of Piles,

TPF-5(140)

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WHAT IS THE NEED?

Bridges, ferry terminals, and other structures constructed over water typically have driven pile foundations. Pile driving in water produces high sound levels in both the surrounding air and underwater environment. Underwater it can produce intense sound, adversely affecting aquatic life and other sensitive receptors. For this reason, pile driving is a highly regulated construction process. To mitigate the noise impact while ensuring proper structural integrity, state departments of transportation, harbor districts, and other agencies must be able to forecast the acoustical properties of the sound that a project will generate. However, relatively little is known about the process of underwater sound generation and propagation from pile driving. Understanding the acoustical properties and the noise potential of pile driving helps government agencies and private entities select the appropriate materials and methods for pile driving to minimize the adverse impacts of underwater sound.

WHAT WAS OUR GOAL?

The goal was to develop a scientific understanding of how the variables associated with pile driving, such as pile material and hammering characteristics, influence the generation of underwater sound and investigate ways to reduce aquatic noise.

WHAT DID WE DO?

Caltrans, as part of this pooled fund study with the Port of Oakland and the Alaska, Virginia, and Washington departments of transportation, investigated the origin and propagation of sound waves from underwater pile driving. The

researchers examined how the characteristics of sound produced during pile driving are influenced by modifications in pile materials, pile shape, hammering, and other variables. The team studied ways to reduce underwater sound close to the piles during pile driving with attenuation systems, synthesizing the information with previous efforts.

WHAT WAS THE OUTCOME?

The dominant underwater noise caused by impact driving is from the Mach wave associated with the radial expansion of the pile. The wave propagates down the pile after impact at supersonic speed. Surrounding the pile underwater with a double-walled steel tube, also called a temporary noise attenuation pile (TNAP), reduces the sound level by approximately 10 decibels. The reduction is limited due to the unconstrained propagation of Mach waves directly from the sediment into the water.

WHAT IS THE BENEFIT?

By using these better practices, quieter PCC pavements that are safe, durable, and cost effective can be built.
The practices address the challenges faced in producing a high-quality product in a low-bid environment. The collected data has shown that quieter concrete pavements do not sacrifice safety because there is no direct relationship between friction and noise.

LEARN MORE

To view the complete report:
www.wsdot.wa.gov/research/reports/fullreports/781.1.pdf

IMAGES

IMAGE 1: Surrounding a 30-inch-diameter pile with a temporary double-walled steel tube to suppress noise

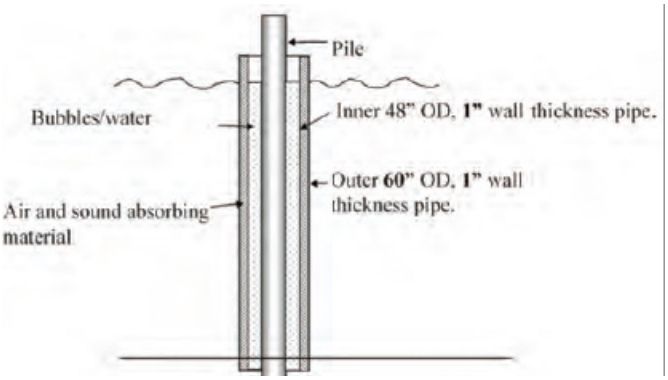

IMAGE 2: Schematic of the TNAP