Vibrating Hammers for Quieter Monopile Installations

With great size comes greater potential for environmental impact, and no where is that more true than in the increasing scale of offshore wind farms. The larger the equipment being developed for these sea-worthy renewable power stations, the more likely it is that they can pose dangers to wildlife and local ecosystems. Noise pollution is one potential problem of particular importance in the offshore wind industry these days.

Monopile and piled jacket foundations have been growing in popularity, and with them so has their size to accommodate the increasing load of larger wind turbine generators. When combined with the drive to create wind farms farther and farther off shore, the market demand for ever larger and deeper foundations also rises.

Yet these types of foundations pose some environmental hazards, noise pollution perhaps chief among them. With increasing regulations for protecting marine life, that means pile driving for these foundation projects will need to shift toward quieter, more sensitive technologies in order to meet the demand.

Challenges with Conventional Monopile Installation in Deep Waters

The noise created underwater during the installation of wind farm foundations can have negative implications for wildlife populations both above and below the water. The sound of driving a monopile, for instance, into the seabed can travel for long distances, creating health concerns for marine mammals, fish, and birds alike. According to one study, the most dangerous effects of the noise are within 100 meters of the site. Projects that span several months pose even greater risks since they can impact the migration patterns of various species. In one study, porpoises could detect the sounds of pile driving from 20 km away.[i]

Many concerns have been raised the noise pollution from pile driving. For fish that swim close enough to pile driving activity, the noise can mean instant death. Further away, fish can be seriously injured and die a short time later as a result of this noise pollution.

Equally troubling is the impact these sounds have on marine mammals such as whales, harbor porpoises, seals, and sea otters. In these species, various sound

gradient levels can alternately create temporary hearing sense shifts and even damage marine mammal hearing to cause permanent hearing loss.[ii]

There have also been concerns over the pile driving process in relation to local seabirds. Issues were raised about a recent installation of monopiles for the Offshore Wind Farm Egmond aan Zee, the Netherlands in early 2006, for instance. An extensive study concluded that few if any birds were disturbed by the construction activity above or below water, in large part due to natural migration cycles and the ambient above-water noise that would have scared these species away from the area. In other words, the project was conducted under ideal conditions resulting in little disturbance to birds. However, the same study did identify potential problems with the behavior of mackerel during the pile driving process.[iii]

The study also pointed out that there remains the potential that birds and many marine mammals and fish to be vulnerable to pile driving disturbances if the right seasonal and ecosystem conditions exist. In this case, many mitigation techniques could be of use:[iv]

- Emitting acoustic deterrents underwater or installing visual deterrents above water (though these have been shown to be less effective over time).
- Working in areas where no or few sensitive bird species reside and/or during seasons when they are absent.
- Employing noise-muffling techniques such as bubble curtains, which are streams of bubbles of air that are released at the base of the monopile and rise up to mask the sound of the pile driving (though this technique is not 100 percent effective).
- Utilizing noise mitigation screens such as those made from double-wall steel combined with bubble curtains.
- Installing hydro sound dampers made of latex balloons and swim noodles.
- Slowly increasing intensity of pile driving to make the first blows less startling and to encourage wildlife to leave the area before the intensity increases.

- Employing a dedicated human observer to watch for the presence of sensitive bird species, and if detected, interrupting or postponing pile driving until they leave the area.

Mitigation strategies like these are fast becoming more and more important in the wind turbine foundation industry as environmental groups and governments push for greater sensitivity to marine life protection. Yet perhaps the most effective solution for minimizing the dangerous underwater noise levels from pile driving is that promised by a new system: vibratory hammers.

How Vibration Hammers are Transforming the Wind Farm Pile Driving Market

One of the leaders in the field of advanced hydrohammer technologies is Dieseko Group whose 300MU Upending Vibro Hammer has been driving the installation of 240 anchoring tripod foundations for the Global Tech 1 wind farm project in Germany. Using a patented vibration technology that results in substantially reduced noise pollution, Dieseko's offshore foundation installation method has significant environmental advantages over conventional monopile installation techniques.

Dieseko's Vibro Technology

The concept behind the vibratory or vibro hammer is to use vertical vibrations to drive sheet piles, pipes, or other elements into the sea bed in order to put adjacent soil particles in motion and loosen the soil. Vibrations are created by two pairwise unbalanced eccentric weights that rotate on a vertical plane to generate a centrifugal force. This up and down motion creates a constant cycle. As the dynamic weight of the hammer drives into the soil to drive the pile, debris is extracted with a crane.[v]

The use of this vibration technique vastly reduces the noise pollution created during the pile driving phase of a foundation project. Noise pollution is an especially serious problem for wind farms being installed in the North Sea where tougher environmental laws require protection of marine life. In Germany, there are regulations that prevent injury and/or killing of specially protected species, including

harbor porpoise and migrating birds. Additional prohibitions prevent the significant disturbance of strictly protected species such as sea birds and porpoise.

The regulations outline zones within which noise impact must be kept to a minimum by either choosing alternative wind farm foundation methods or using mitigation measures such as bubble curtains and vibration hammers.[vi]

German Noise Mitigation Laws

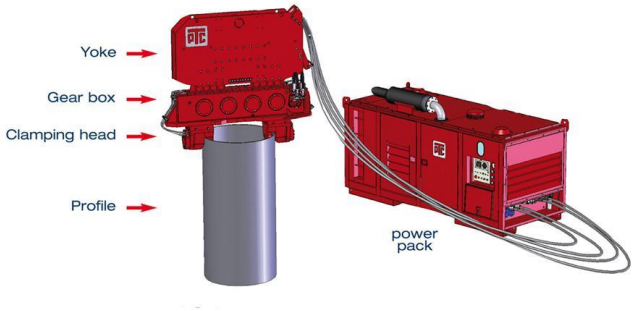
Thankfully, vibration pile driving like that offered by the 300MU has made it possible to create foundations in ever-deeper waters without disturbing the local wild inhabitants to satisfy such regulations. The 300MU is being utilized on board the vessel Innovation, which is a self-elevating ship. The hammer has a maximum centrifugal force of over 6100 kN and lifting power up to 400 tons.[vii]

Not only is the 300MU a quieter system, the vibro hammer technology is also touted as faster compared to conventional hammering. When combined with their proprietary upending technology, the system also made installation quicker and deck occupancy lower. This is because the upending system of the 300MU lifts horizontal stored piles into the vertical position and then vibrates the piles in one sequence which lowers both time spent on the project and deck space. No additional internal lifting tools are required. The combined time and deck space reductions means this technology has the potential to significantly reduce drive piling costs.

When complete, the Global Tech I installation will have 80 turbines (three piles each) and will produce 400 MW of energy, which is enough to provide electricity to 445,000 households.[viii] The project is set for completion later this year.

Another player in the vibrating pile driver market space is PTC, a company that has supplied Denmark-based offshore wind developer DONG Energy with hydraulic hammers for their Anholt wind farm. Working off the east coast of Denmark

between Grenaa and the island of Anholt, the 400 MW wind farm project needed to be completed with as little noise pollution as possible to meet local regulations.



PTC Vibrodriver Technology

Like the 300MUs, PTC's Vibrodriver uses a hydraulic vibration hammer to create vertical vibrations that drive sheet piles, concrete, I beams, H beams, wooden piles, and other profiles into the seabed.[ix] This technology creates a much quieter work process that satisfies German laws for noise emissions under water, which requires that noise levels not exceed 160 dB at 750 meters.

Engineering innovations like these are incredibly inspirational for project managers and investors. Not only do they solve regulatory challenges, in the process they also have the potential to lower installation costs. When environmental and financial goals can be met simultaneously with a single solution such as a vibration hammer, everyone wins.

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A student of all things green, Maryruth has a special interest in cleantech and green buildings. In recent years, Maryruth has worked as the senior editor of The Green Economy magazine, is a regular blogger for several green business ventures, and has contributed to the editorial content of not one, but two eco-living websites: www.ecolife.com and www.GreenYour.com. You can learn more about Maryruth's work by visiting her site, www.jadecreative.com.

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