A Layman's View of Sediment Scour Around the Base of Offshore Turbines:

A Case for Construction of Enhanced Habitat

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Author's note: This article is presented as a positive suggestion of how wind turbines can provide some benefit to the marine environment. In no way should this be construed as a blanket acceptance of wind turbines in areas important to recreational and commercial fishers. In addition to positive modifications such as what is proposed in this article, an aggressive program of testing and documentation will be necessary to help minimize impacts that these large wind farm developments have on the existing fisheries south of New England. Potential impacts from sound generated during operation and the cumulative impact of many turbines must be thoroughly investigated and mitigated to the fullest extent possible.

It is well known that sediments around the base of any structures placed through the sea floor can be subject to movement due to ocean currents and waves as these currents or wave energy move around the new structure. This process is known as **sediment scour** and can cause extensive sediment movement. This sediment movement is caused by increased water flow velocities as water movement is affected by the new structure.

Scour is greater with larger diameter structures such as turbine monopile bases, which are proposed to be approximately 30 feet in diameter in the case of the projects off New England. This greater scour is caused by water being displaced further as it makes its way past this large stationary structure.

Scour is dependent on current velocity, water depth, wave height, and sediment type, but equilibrium scour depth is approximately 2 times the tower diameter (S/D = 2.0) or 2.7 or design purposes; (where S is the scour depth and D is the diameter of the monopile), or 60 feet of scour depth for a tower base of 30 feet in diameter.

Local scour: The erosion of seabed material in proximity to a single foundation, e.g. a monopile or a single leg of a jacket foundation (From Epsilon, 2018)

This scour imposes significant influence on the stiffness of the monopile foundation and changes the natural frequency and fatigue life of the structure (Wen-Gang, 2019). These changes are a significant factor during design and operation of monopiles since monopiles are hydrodynamically sensitive structures and are both prone to and sensitive to scour. In fact, until recently monopiles were not considered useable in water depths over 30 m (90 feet).

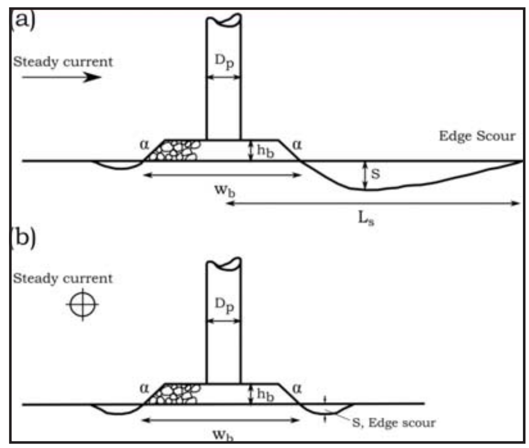
Bhattacharya, 2014 indicates that "Preliminary calculations suggests that 10m diameter monopiles weighing 1200tonnes may be suitable for 45m (148 feet) water depth and of course dependent of ground conditions."

This indicates that the use of monopile construction in areas south of Nantucket is pushing the envelope in terms of foundation design based on existing water depth and therefore any scour potential is particularly important and must be reduced to the greatest extent possible.

For all of the reasons given above most monopile bases for offshore wind towers are protected with a "scour pad."

This is typically a pad of rock that is placed around the base of the turbine to act as sediment cover that can not be moved by the increased current or wave action. For a monopile 30 feet in diameter this scour pad would extend roughly 75 to 150 feet out from the base in all directions and could be 1 to 6 feet thick. In the case of Vineyard Wind the preliminary design document calls for 650 m3 or 1300 MT of stone at the base of each turbine (Epsilon Associates, 2018). This equates to about 23,000 cubic feet or 1400 tons for each turbine.

The problem that has been identified with a standard pad such as this consisting of rock is that the rocks themselves cause increased water flow velocity and therefore some sediment scour.



From Petersen, 2014

This leads to edge scour or secondary scour. This edge scour has been shown to continue over time and can eventually undermine rocks near the edge of the scour pad, causing them to collapse into the scour hole produced, compromising the scour pad and causing exposure of cables running between monopiles (Petersen, 2014).

So how can the sediments around the base of a turbine be protected and the velocity of water around the edges of this scour protection be reduced at the same time?

I believe that complex structures such as uneven surfaces with branches extending outward and hollow structures where some water can move around or through will decrease edge velocities and therefore reduce edge scour. Just as riprap is used to absorb and dissipate wave energy by placing large angular rock or shaped concrete units such as Dolos, Xbloc, Terapod, etc. By placing angular and hollow structures as part of the scour pad the energy of water moving across the scour pad due to either wave action or current will be dissipated in the immediate area of the sediment interface and edge scour will be reduced. **(to page 32)**