**Important Considerations when Protecting Floating Offshore Power Cables**

Critical to the successful operation of offshore windfarm technology are the essential subsea power cables transmitting generated power from the turbines to the substations (electric hub of the windfarm), and then onward to shore. Protecting these critical power cables from excessive movement or bending that could potentially cause fatigue damage is of utmost importance.  High voltage power cable replacement costs are in the region of millions of Euros, even before factoring in wind turbine down-time and the huge loss of revenue from reduced output.

**Why Is Cable Bend Protection Needed?**

Whilst numerous kilometers of power cables are installed on every windfarm, they are vulnerable to damage at a number of critical locations, one of the key ones being the connection points into the turbine or substation foundation.

With fixed wind turbine structures, the cable is typically protected through trenching and burial for the majority of its length, with exposure in the approach towards connection points. With floating wind platforms, the cable is exposed over longer lengths in the water column between the seabed and the floating foundation of the turbine and will potentially experience even greater levels of dynamic load and motion.

In these exposed areas, the dynamic forces on the cable produces cyclical motions relative to the foundation. These motions and loads concentrate towards the rigid connection point where the cable experiences a sharp transition in stiffness. As the cables have relatively low stiffness, they are highly susceptible to both over-bending and fatigue damage at this point. To mitigate this, bend protection is needed.

**Cable Bend Protection Analysis and Design**

In order to analyze the application and develop a bend protection device that is fit for purpose, the following parameters are critical design considerations:

Met ocean data: Detailed information is required in order to determine the conditions the cable will be subjected to.

Temperature: The mechanical performance characteristics of polymer materials used in cable and bend protection device construction can vary with temperature.

Cable dimensions and weight: These cable parameters determine the nature of reaction against the wave and current dynamic forces and therefore influence the level of loads and motion on the cable.

Cable mechanical parameters: The cable’s bend stiffness and minimum bend radius (MBR) characteristics are essential for assessment of the suitability of any proposed bend protection device.

Cable thermal characteristics: As the bend protection surrounds the cable it can insulate the cable and increase the cable temperature. Thermal analysis is necessary to check that the cable does not exceed its allowable temperature limits.

Once a bend protection system is identified that satisfies dynamic performance requirements, the output can be used to proceed to local mechanical design of the bend protection system and its components, and thermal analysis including the cable to verify allowable temperature limits are maintained.

**Dynamic Cable Bend Stiffeners**

For dynamic bend protection applications, a bend stiffener solution is recommended to maintain cable integrity.

Designed to provide a gradual and tailored transition in stiffness from its tip to its base, this is a crucial feature of a bend stiffener as this removes the sharp change in stiffness at the connection point and protects the cable from over-bending and excessive fatigue. The bend stiffener provides continuous support to the cable at the connection point, ensuring the overall curvatures of the cable inside and adjacent to the bend stiffener are significantly reduced when under load.

Trelleborg utilizes dynamic bend stiffeners in the fixed wind applications as part of its NjordGuard Cable Protection System and on floating wind applications, often mated to a Diverless Bend Stiffener Connector for quick installation.

**Summary**

Utilizing a bend stiffener over other bend protection solutions, provides the most appropriate design solution for cable connection points on fixed and floating offshore wind structures where the cable is exposed to dynamic environmental conditions, ensuring continuous protection of the cable from over-bending and fatigue.

As applications are often unique in their requirements, careful analysis of the parameters is necessary in order to identify the most appropriate bend protection solution. Selecting the right bend protection solution for both the specific wind turbine and the environment, will prevent cable damage and subsequently reduce operations and maintenance costs by maximizing the life of the cable, removing the need to prematurely replace or repair cables in service.