Mechanical Testing of Offshore Wind Turbine Materials

Offshore wind turbine structures are usually made of steel materials. The tower of an offshore wind turbine is typically made of steel, while the foundation can be made of either steel or concrete. A monopile foundation is a type of foundation used for offshore wind turbines and is made of steel. A monopile foundation consists of a single, cylindrical steel pile that is driven into the seabed to provide stability for the wind turbine tower. Monopile foundations are commonly used in shallow waters and are suitable for sites with a soft seabed. The nacelle, which houses the generator, gearbox, and other mechanical and electrical components, is typically made of composite materials such as fiberglass. The blades of the wind turbine are made of composite materials such as fiberglass, carbon fiber, or a combination of both. These materials are used for their durability, strength, and lightweight properties, which are essential in harsh offshore environments.



Charpy Impact Test for Metallic Materials

Most Charpy impact test method for metallic materials is specified by European EN 10045 standard. This specification defines terms, dimension and tolerances of test pieces, type of the notch (U or V), test force, verification of impact testing machines etc. The test consists of breaking by one blow from a swinging pendulum, under conditions defined by standard, a test piece notched in the middle and supported at each end. The energy absorbed is determined in joules. This absorbed energy is a measure of the impact strength of the material.

The Charpy impact test (Charpy V-notch test) is used to measure the toughness of materials under impact load at different temperatures. The standard test piece shall be 55 mm long and of square section with 10 mm sides. In the centre of the length, there shall be a notch. The plane of symmetry of the notch shall be perpendicular to the longitudinal axis of the test piece.



Material: EN 1.0456 / ASTM A333 Grade 6

The EN 1.0456 / ASTM A333 Grade 6 carbon steel material is a material for offshore wind turbines monopile foundations. The material specification is developed for low-temperature service carbon steel seamless pipes for use in industrial applications.

EN 1.0456 / ASTM A333 Grade 6	
Grade	Carbon steel
UNS	K03006
Alloying elements and composition (wt%)	C:0.30% Mn:0.29-1.06% P:0.025% S:0.025% Si:≥0.10%
Microstructure phases	Multi-phase alloy
Matrix phase (continuous phase)	Ferrite
Dispersed phase (second phase/particles)	Pearlite
Strength (20°C)	YS: ≥ 240 MPa, UTS: ≥ 415 MPa, TE: ≥ 16.5%, Hardness (HV): 166.8, Charpy K _{CV} (-55°C): 120 J
Corrosion resistance/PREN	0.00, high as galvanized and painted
Weldability	Excellent due to extra-low carbon
Material manufacturing and processing	Formed as a seamless and welded pipe



100 µm

Light phase: Ferrite

Heat treatmentAnnealed at a uniform temperature at minimum 815°C
followed by quenchingIndustrial applicationsSeamless and welded pipes, low-temperature serviceCarbon steel EN 1.0456 / ASTM A333 Grade 6 is a common material for offshore wind turbine monopile
foundations.

Dark phase: Pearlite

Western Norway University of Applied Sciences