Evaluation of Heavy-Gauge 690 MPa-Class Offshore Steel Racks Required in Modern Wind Turbine Installation Vessels

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INTRODUCTION

Today offshore wind energy is expanding rapidly as an accepted answer to deliver cleaner and renewable electricity and lower CO₂ emissions. Since the first offshore wind farm built in 1991 in Denmark, the global installed offshore wind capacity has reached around 56 GW in 2021 and is expected to grow to 200+ GW until 2035. The ongoing need to reduce the costs associated with offshore wind farms has led to the development of larger turbines measuring up to 260 m in height with an output in the range of 10 to 20 MW per turbine [1].

The increase in the scale of the turbines requires an adaptation of the installation vessels in terms of carrying and lifting capacities. A wind turbine installation vessel (WTIV) is a special installation vessel used to transport the various turbine components on their deck and possesses cranes with high lifting capacities for installing them in ever-increasing operating water depths up to 80 m. To create a stable working platform and safely install the turbine components, these vessels have jack up legs with racks and pinions used to elevate their deck above the sea surface (Figure 1).

These legs are like those in jack-up platforms used as drilling units for oil & gas exploration and offshore structural steel with a nominal yield strength of 690 MPa is the reference material of choice in this application. Yet, there is a great difference in rack wear and fatigue between rigs that are moved every few months and installation vessels that are moved daily [2]. Jack-up racks for wind turbine tower installation vessels require stronger teeth to withstand the enhanced wear and fatigue solicitations caused by the higher frequency of up and down operations compared to classical oil and gas exploration drilling rigs. That is why design of the last generation of WTIV is frequently upscaled up to 250 mm thick racks instead of the standard 180 mm gauge used for drilling platforms.

From the steel manufacturer perspective, maintaining the same material performance while increasing the section is not a simple task. The same or better mechanical properties shall be guaranteed for the whole thickness and the material characteristics in terms of processing and welding must be qualified. This study considers the experimental characterization of 210 and 250 mm thick base metal plates industrially produced by Industeel in France.