Development of a Repair Technique for Cracking in Wind Turbine Nacelle Bed Plates
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Abstract

In 2012, E.ON discovered cracks in the welded joints of the rear bed plates in the nacelles of V66 wind turbines at Deuchner Hill onshore windfarm. This prompted E.ON to carry out inspections of other Vestas turbines and cracking was identified in V80 turbines at Scroby Sands offshore windfarm. The cracks were found at the welded joints between both the generator and cabinet side beams and the transformer rear beam. Subsequently, cracks were found at the welded flange that joins the cabinet side beam to the central section of the nacelle bed plate. These cracks are more significant as they are close to the main bolting connection to the front assembly of the nacelle and therefore more difficult to repair as it is not possible to remove all these bolts at the same time.

Uniper Technologies has developed a methodology for repair that has been carried out successfully, with no cracks re-initiating. However, cracking continues to emerge in other nacelles so there is a continual requirement for regular inspections.

Weld Repair Procedure

Original requirement specification for V66 (Mark 1.5) / V80 (Mark 1.5) rear frame crack repair was developed by Vestas. Uniper requires welding contractors to complete simulation tests that mimic site conditions and defects as closely as possible. This maximises learning in the workshop whilst minimising issues on site. The rear frame is composed of box sections that are galvanised internally and externally. There is no access to remove the internal galvanised coating. Uniper has carried out metallographic examination of test specimens to understand the effect of welding on the internal galvanised coating.

Fracture Mechanics Calculations

Because of the proximity of the cracks at the front assembly of the nacelle to the bolting system, it is necessary to remove the nearby bolts to carry out the weld repair. However, they cannot all be removed at the same time, so a maximum number of adjacent bolts that can be removed safely and a sequence for their removal need to be determined. Uniper Technologies carried out finite element stress analysis and fracture mechanics calculations to demonstrate the stability of the cracks, the resistance of the structure to buckling or plastic collapse, and calculate the bolts loads, in support of the development of a safe bolt removal sequence. A variety of cases was calculated to account for cracks of varying lengths and positions on the cabinet side.

Results

- Repairs were carried out at Deuchner Hill wind farm in 2013 which have been periodically re-inspected to verify that no new cracks have re-initiated;
- Samples of cracking have been removed and confirmed to be fatigue cracks;
- Further repairs have been carried out at Scroby Sands in 2014, and inspected on a regular basis to verify no cracking has re-initiated;
- In 2016, a new population of cracks was identified in unrepaired wind turbine nacelles. A repair programme is currently underway.

Conclusions

- An inspection programme has been implemented to monitor crack growth;
- A weld repair procedure and rear reinforcement plates have been used to successfully repair cracks that are over 1m in length;
- A safe bolt removal sequence for the front location has been developed that depends on the crack length and position;
- The nacelle bed plate can be repaired successfully.

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