



**OTC 21140**

## **Fatigue Life Extension by Ultrasonic Peening for Offshore Structures: As-built Weld Quality and Overloads during Remaining Service Life**

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### **Abstract**

The fatigue life extension procedure by ultrasonic peening uses FEA to assess the critical weld details and to define the location and extension of the areas to be treated. However, FEA models do not take into account variations in as-built weld quality. Areas with moderate level of stresses but showing varying weld quality might benefit of ultrasonic peening treatment as much as areas with the highest stresses. The ultrasonic peening procedure takes into account certain weld parameters originating in the as-build quality so these can be improved during the application of the treatment in order to achieve full benefit.

As-built weld quality has a great influence on the fatigue life of offshore structures. Hence the fatigue life extension procedure needs to address the implications of a low as-built weld quality previous to the application of the ultrasonic peening procedure. When as-built weld quality limits the targeted fatigue life, ultrasonic peening could enhance the fatigue strength up to a desired level. For weld details which have already consumed half of their fatigue life ultrasonic peening can reset the clock to zero.

The increased fatigue resistance due to ultrasonic peening treatment is partly based on the introduction of compressive stresses. Extreme load conditions could redistribute the compressive stresses and therefore it is necessary to verify if the improvement would be still present during the remaining service life of the installation. Therefore fatigue testing with compressive preloads has been carried out on ultrasonic peening treated specimens.

Despite the extreme low weld quality, the ultrasonic peening improved weld details, showed a factor 2 in fatigue life extension which is a value presented in literature as a lower band for the improvement. This improvement is estimated to be unchanged even if overloads could relax the induced compressive stresses.

The poor weld quality have reduced the level of improvement to a factor 2 in life and therefore it is recommended an improvement of weld angle by machining before the application of ultrasonic peening when required.

For structural details with low as-built weld quality ultrasonic peening treatment could be the only solution left to enhance the fatigue life avoiding weld repair.

The economical benefits due to reduced weld repair and/or maintenance on offshore installations as a result of the ultrasonic peening treatment include:

- Restore the fatigue strength for structural details with poor weld quality
- Avoidance of a long term plan for extensive weld repair or hot work
- Avoidance of long and unscheduled operational disruptions
- Increased structural safety for the installation during the remaining service life