

STATE-OF-THE-ART: FATIGUE LIFE EXTENSION OF OFFSHORE INSTALLATIONS

Luis Lopez Martinez
LETS Global
Rotterdam, Netherlands

Zuheir Barsoum
Royal Institute of Technology - KTH
Stockholm, Sweden

Anna Paradowska
Bragg Institute
Kirrawee, NSW, Australia

ABSTRACT

The use of fatigue life improvement techniques and specifically ultrasonic peening treatment to extend the service life of offshore structures has become an accepted practice during the last five years. The understanding of the process as well as equipment's upgrading for treatment in-situ including quality control and assurance have been developed up to a level that it has become a current practice in many parts of the world.

However, the efficiency of the ultrasonic peening is strictly dependent on the deep understanding of significant fatigue parameters as weld defects, stress concentrations and residual stresses and their interaction. In this paper we attempt to present the current knowledge and the physical reasons why the ultrasonic peening treatment is able to improve the fatigue life of welded joints.

The local weld geometry or stress concentration, weld imperfections as well as welding residual stresses are all modified and improved by the application of ultrasonic peening.

Local weld geometry and weld process inherent weld imperfections are the factors primarily influencing the fatigue strength in welded joints. Comprehensive studies have been carried out during the last 20 years in order to detect and document the weld defects as well as to understand their origin and effect on the fatigue strength of welds. Analogous efforts have been dedicated to understand and document the influence

of local weld geometries on the stress concentrations and its influence on endurance and structural integrity.

Similarly, efforts have been done to understand the influence of the relaxation by external loads of the by the ultrasonic peening treatment induced compressive stresses.

Fatigue test results of ultrasonic peening treated relevant weld details have been used to assess the potential life extension. The results showed four to six times fatigue life extension. The spectrum fatigue test was designed to confirm that relaxation by service loads of the induced compressive stresses during ultrasonic peening treatment would not diminish the benefit.

INTRODUCTION

Many offshore installations around the world are reaching their original design life. Most of the operators chose to extend the service life of their assets rather than scrape them and/or build new. As a result of this trend the application of fatigue life improvement techniques in-situ and specifically ultrasonic peening has become very popular. However, the successful application of fatigue life improvement techniques must be based on the knowledge of the three main factors and their interaction affecting the endurance of welds of structural integrity concern: weld imperfections, geometrical stress concentrations and residual stresses. These three factors and their reciprocal influence are the target of any fatigue life improvement technique. Consequentially, it is only the ultrasonic peening treatment which is able to tackle and/or