Effect of Ultrasonic Peening on Fatigue Strength of Welded Marine Structures - Lloyd’s Register Research Programme

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ABSTRACT

The paper describes the Lloyd’s Register Research Programme focused on investigation of effect of ultrasonic peening on fatigue strength of welded marine structures. The topics specific to marine structures include large scale model testing, effect of corrosion and influence of compressive cycles in load sequences. The results of three sets of fatigue testing are presented and conclusions are drawn.

KEY WORDS: Fatigue tests, welded joints, ultrasonic peening, large scale models, corrosion, compressive cycles in marine load sequences.

INTRODUCTION

Ultrasonic Peening (UP), Ultrasonic Impact Treatment (UIT), Ultrasonic Impact Peening (UIP) are post weld improvement methods, in which ultrasonic energy is applied to a metal object. For the sake of simplicity in this paper the method will be called UP method. Fatigue performance of UP treated welded joints is known to be superior to that of as-welded joints. This is due to fact that UP process has two effects on joint; firstly, it reduces the stress concentration at the weld toe by introducing a smooth radius and secondly, it modifies the microstructure of the weld toe metal by creating a compressive residual stress in the treated zone. The benefits of UP technique have been highlighted in many publications too numerous to be referenced in this paper. As follow-up to these studies International Institute of Welding (IIW) is preparing new Guidance (Marquis et al, 2013) where fatigue improvement factors will be provided. These factors are not specific to any particular structures or loading patterns.

The benefit to shipbuilding of UP technique when compared to other peening techniques is that the tools required for this treatment are portable, easy to use, and both user and environment friendly (little noise is produced).

In 2007 Lloyd’s Register (LR) was requested to approve the use of UP as post weld improvement method in ship and offshore structures, which was initially done on case to case basis. However there were concerns with regards to use of UP in marine structures. These concerns were as follows:

- Would benefits obtained for small specimens still be valid for large welded structures?
- Would corrosion affect the performance of UP treated welded joints?
- Would loading histories specific to marine and offshore structures reduce residual stress produced by UP affecting fatigue lives of UP improved welded joints?

Therefore since 2007 three sets of fatigue testing were performed to