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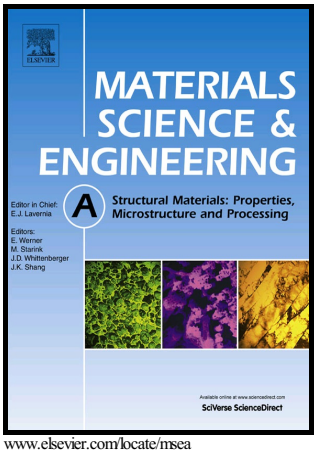

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The influence of hydrogen on deformation under the elastic stress in mooring chain steel

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Abstract

The cyclic deformation was investigated under cyclic stress with different maxima in seawater or simultaneously charging hydrogen for a tempered mooring chain steel. The loss of fatigue life in seawater is similar as that charged hydrogen, suggesting that the deterioration in lifetime caused by harsh seawater should mainly result from hydrogen evolution rather than anodic dissolution. Hydrogen can enhance bowing mobility of mobile dislocation and hence increase the recoverable displacement although local plastic is not obvious. In the meantime, hydrogen can promote the diminution of elastic modulus, which is always accompanied by an extra of internal friction.

Keywords: mooring chain steel; recoverable displacement; elastic modulus; internal friction.

1. Introduction

In recent years, the upgrading of mooring chain steel towards higher strength has been demanded for deep sea platforms. However, high strength steel is prone to hydrogen embrittlement (HE) [1-2] and it has been reported [3-4] that in the presence of hydrogen, the fatigue life in the region of low cycle fatigue can decrease significantly by so much as ≈70-80% on a medium strength steel. Extensive experiments on fatigue mainly concentrate on the investigation of pre-cracked compact tension specimens and illustrate their rule of fatigue crack growth rates and fracture [5]. There hydrogen is usually considered to rather accelerate the crack growth rate than affect the final fracture process, but seldom work carried out on the crack initiation period. Nevertheless, the main fracture of mooring chain may result from corrosion fatigue due to hydrogen in marine corrosion and the sea wave mainly causes mooring chain deformation under elastic stress. Hence the influence of hydrogen on this damage, especially on the process before crack initiation, is intriguing in investigation of the corrosion fatigue.

For pure elastic, reversible and energy preserving, the deformation only expresses atomic bond