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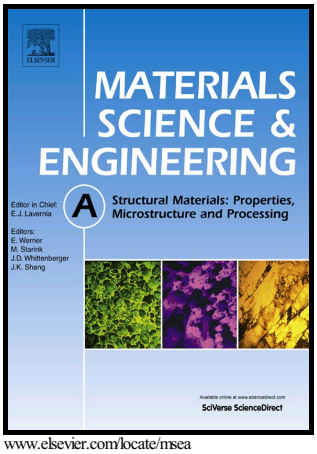

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Analysis of Key Factors of Hydrogen Environmental Assisted Cracking Evaluation by Small Punch Test on Medium and High Strength Steels

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ABSTRACT

In this paper, the response of a high-strength and a mid-strength steel in response to hydrogen embrittlement processes are analyzed by means of the quasi-non-destructive test known as the Small Punch Test (SPT). The SPT has been successfully employed in the evaluation of tensile properties, creep behavior, fracture, and some recent research proposes that it might be applied for the determination of mechanical properties in brittle scenarios.

In a first stage, standardized hydrogen embrittlement and stress corrosion cracking testing techniques have been applied, confirming some of their disadvantages, and the SPT has been proposed as a simple and economic alternative when it is not possible to carry them out. It is recommended to use the SPT under static load, with the specimen pre-charged and submerged in the environment during the whole test. The study is completed with hydrogen content measurements.

Based on the experimental results of slow strain rate tests (SSRT), and the SPT performed under static load in embrittlement environments, it was proved that the SPT punch displacement versus time to rupture curve has the same typology as the usual creep curves. Inspired on SPT creep methodologies, a simple and effective way to correlate the results of SPT and conventional tests in embrittlement situations is proposed. It is based on matching the same breaking times in both types of tests when performed under the same environment to obtain the rupture stress from the static loads applied in SPT tests.

Subsequently, it is proved that for the aforementioned situations, the numerical value of the deformation rate (uniaxial test) and the punch rate (SPT) that take place during these two tests will be alike for similar rupture times. Finally it is pointed that when the uniaxial slow strain rate test maximum stress and the SPT static load have a similar numerical value, the deformation rate (SSRT) and the punch rate (SPT) will be related, thus providing a simple way to estimate deformation rates using SPT instead of conventional SSRT tests.

Keywords: Small Punch Test, Hydrogen environmental assisted cracking, Slow strain rate tests, Medium and high strength steels.

1. INTRODUCTION