Numerical Analysis of Abnormal Fracture Occurrence in Drop Weight Tearing Test for X70 Pipeline Steel Using Ductile-Brittle Combined Fracture Model

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ABSTRACT

In this paper, the ductile-brittle combined local fracture analysis was performed on drop weight tearing test (DWTT) of API X70 pipeline steel. To control a failure of pipeline, the dynamic cracking arrest capability is very important. As a standard test, DWTT is generally used to measure the dynamic cracking arrest capability[1]. However, for high performance pipeline steel, such as API X70, the abnormal fracture is often occurred on fracture surface of DWTT specimens. Since the abnormal fracture make hard to evaluate the dynamic cracking arrest capability, it is necessary to analyze the brittle fracture occurrence during ductile crack propagation.

To simulate the ductile crack propagation of DWTT specimen, the stress modified fracture strain model was applied as a ductile damage model[2]. To determine the ductile damage model, tensile and single edge notch tension (SENT) tests were used. To consider dynamic effect on material properties, rate-dependent stress-strain relations were used. After that, to analyze the brittle fracture probability during ductile crack propagation, the Beremin model was applied based on the ductile simulation results[3]. The Weibull parameters in Beremin model were calibrated by comparing with ductile fracture area from experimental results of DWTT. The analysis results confirmed that the dynamic ductile fracture can be simulated using the stress modified fracture strain model based on stress triaxiality. It also confirmed that as the ductile fracture progresses, the Weibull stress increases due to the increase in the size of the fracture process zone at the DWTT specimen and the probability of brittle fracture increases.

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