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Fracture Behavior Pipe-Ring Specimens for Fracture Toughness Testing of Thin-Walled Pipelines

Nenad Gubeljak [1], Andrej Likeb [1], Darko Damjanović [2], Dražan Kozak [2], Luka Ferlič [1]

[1] Smetanova 17, 2000 Maribor, Slovenia, University of Maribor, Faculty of Mechanical Engineering
[2]108. Brigade ZNG 36, 35 000 Slavonski Brod, Croatia, University of Slavonski Brod, Mechanical Engineering Faculty in Slavonski Brod
*corresponding author: nenad.gubeljak@um.si

Abstract

Structural integrity assessment of the pipelines requires fracture toughness in order to predict the loading capacity of pipeline or resistance to the initiation and crack growth. The thin-walled structures as pipelines are usually unsuitable for the standard testing of fracture toughness. Particularly, it is very difficult to perform the fracture toughness testing in the case of longitudinal surface cracks. To find an alternative technique for the measurement of fracture toughness of the already delivered pipeline segment, the pipe-ring notched bend specimen (PRNB) has been proposed. In this paper the differences in fracture behavior between the standard single edge notch bending (SENB) and non-standard pipe-ring notched bend (PRNB) specimens are discussed. To avoid the uneven fatigue crack front because of complex fatigue loading which caused different fracture behavior, the standard single edge notched bend (SENB) specimens has been used for comparison to ring specimens. The fracture toughness was measured by testing both types of specimens. The critical crack tip opening displacement was determined as a crack tip surface strain-relaxation by using stereo-optical grading method and compliance method. The comparison between CTOD-R curves of both standard and non-standard specimens shows comparable similarity in fracture behavior, especially in the stable crack initiation, but shows significant difference during ductile tearing.

Key words: Pipe-ring specimens, Fracture toughness, Bending specimens, CTOD-R curves

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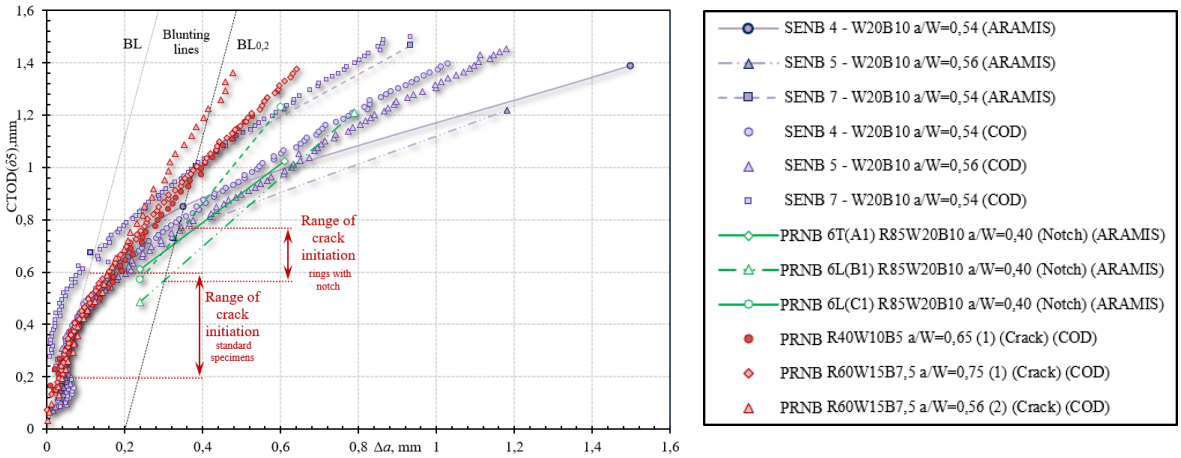

Figure 1. Comparison of the CTOD-R resistance curves between rings and standard specimens