Accepted Manuscript

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PII: S1738-5733(17)30552-1

DOI: 10.1016/j.net.2018.01.020

Reference: NET 508

To appear in: *Nuclear Engineering and Technology*

Received Date: 7 September 2017

Revised Date: 22 January 2018

Accepted Date: 30 January 2018

Please cite this article as: H.W. Jang, D. Hahm, J.-W. Jung, J.-W. Hong, Effective Numerical Approach to Assess Low-cycle Fatigue Behavior of Pipe Elbows, *Nuclear Engineering and Technology* (2018), doi: 10.1016/j.net.2018.01.020.

Effective Numerical Approach to Assess Low-cycle Fatigue Behavior of Pipe Elbows

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Abstract

We develop numerical models to efficiently simulate the low cycle fatigue behavior of a pipe elbow. In order to verify the model, in-plane cyclic bending tests of pipe elbow specimens were conducted and a through crack occurred in the vicinity of the crown. Numerical models based on the erosion method and the tie-break method are developed and compared with experimental results. The calculated results of both models are in good agreement with experimental results, and the model using the tie-break method possesses two times faster calculation speed. Therefore, the numerical model based on the tie-break method would be beneficial to evaluate the strength of piping systems under seismic loadings.

Keywords Low-cycle fatigue, fracture, finite element method, pipe elbow

1. Introduction

Since the Tohoku earthquake in 2011, the importance of the safety and redundancy of nuclear power plant structures has increased substantially. In the event of a disaster such as an earthquake or a tsunami, coolant must be steadily supplied to the reactor to shut down the plant safely. If the coolant is not