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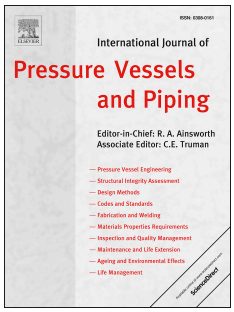


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Yeji Kim, Il-Soon Hwang, Young-Jin Oh

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# Unified Formulae for Evaluating Load Reduction by Change in Stiffness of Circumferential Crack Considering General Piping Systems

Yeji Kim[1], Il-Soon Hwang[2], Young-Jin Oh[3*]

[1]Korea Institute of Nuclear Safety, 62 Gwahak-ro, Yuseong-gu, Daejeon, 34142, Republic of Korea

[2]Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul, 08826, Republic of Korea

[3*]KEPCO Engineering and Construction Co. Inc., 269 Hyeoksin-ro, Gimcheon, Gyeongsangbuk-do, 39660, Republic of Korea

*Corresponding Author: Tel: +82 54 421 6463, Fax: +82 54 421 6462,

E-mail: yjoh2@kepco-enc.com

## Abstract

The conservatism of leak-before-break (LBB) analysis depends on the methodologies for evaluation of the crack opening displacement (COD) and crack stability analysis, in which the applied load at the cracked section is an important variable. In current procedure, the applied loads are obtained from an uncracked pipe analysis, and the effect of restraint is not assumed in the calculations of COD and the allowable applied moment. When the presence of a crack and the pipe restraint are considered, however, the applied load can be reduced because of the change in the piping system stiffness. In this regard, there have been several proposed analytical expressions to evaluate the restraint effects on COD or crack stability analysis, but the expressions cannot be applied to practical cases because of the limitation of the pipe geometries and applied loading conditions. This study develops unified formulae to evaluate the effective applied loads that enable balanced analyses of both the COD and stability of circumferential cracked pipes. The formulae were developed for a piping system containing a circumferential crack based on the compliance approach. By comparing this with finite element analysis results, the validity of the formulae was demonstrated. It is expected that the proposed formulae can be used as a simple approach to detailed LBB analysis to secure the safety margin before implementing the complex non-linear finite element analysis.

**Keywords:** Load Reduction, Pipe restraint effect, Leak-before-break evaluation, Crack opening