Accepted Manuscript

Statistical Analysis of Parameter Estimation of a Probabilistic Crack Initiation Model for Alloy 182 Weld Considering Right-Censored Data and the Covariate Effect

Jae Phil Park, B.E., Chanseok Park, Ph.D., Young-Jin Oh, Ph.D., Ji Hyun Kim, Ph.D., Chi Bum Bahn, Ph.D.

PII: S1738-5733(17)30321-2

DOI: 10.1016/j.net.2017.09.005

Reference: NET 438

To appear in: *Nuclear Engineering and Technology*

Received Date: 5 June 2017

Revised Date: 28 August 2017

Accepted Date: 20 September 2017

Please cite this article as: J.P. Park, C. Park, Y.-J. Oh, J.H. Kim, C.B. Bahn, Statistical Analysis of Parameter Estimation of a Probabilistic Crack Initiation Model for Alloy 182 Weld Considering Right-Censored Data and the Covariate Effect, *Nuclear Engineering and Technology* (2017), doi: 10.1016/j.net.2017.09.005.

Original Article

Statistical Analysis of Parameter Estimation of a Probabilistic Crack Initiation Model for Alloy 182 Weld Considering Right-Censored Data and the Covariate Effect

Jae Phil Park(B.E.)[a], Chanseok Park(Ph.D.)[b], Young-Jin Oh(Ph.D.)[c], Ji Hyun Kim(Ph.D.)[d] and Chi Bum Bahn(Ph.D.)[a*]

[a] School of Mechanical Engineering, Pusan National University, Busan 46241, Republic of Korea

[b] Department of Industrial Engineering, Pusan National University, Busan 46241, Republic of Korea

[c] Korea Electric Power Corporation (KEPCO) Engineering and Construction, Co, Ltd, Gimcheon 39660, Republic of Korea

[d] Department of Nuclear Engineering, School of Mechanical and Nuclear Engineering, Ulsan National Institute of Science and Technology (UNIST), Ulsan 44919, Republic of Korea

[*] Corresponding author - Address: 2, Busandaehak-ro 63beon-gil, Geumjeong-gu, Busan 46241, Republic of Korea; Phone: +82-51-510-1033; E-mail: bahn@pusan.ac.kr

Keywords: PWSCC, Weibull distribution, xLPR, MLE, Bootstrap

Abstract

To ensure the structural integrity of nuclear power plants, it is essential to predict the lifetime of Alloy 182 weld, which is used for welding in nuclear reactors. The lifetime of Alloy 182 weld is directly related to the crack initiation time. Due to the large time scatter in most crack initiation tests, a probabilistic model, such as the Weibull distribution, has mainly been adopted for prediction. However, since statistically more advanced methods than current typical methods may be applied, we suggest a statistical procedure for parameter estimation of the crack initiation time of Alloy 182 weld, considering right-censored data and the covariate effect. Furthermore, we suggest a procedure for uncertainty evaluation of the estimators based on the bootstrap method. The suggested statistical procedure can be applied not only to Alloy 182 weld but also to any material degradation data set including right-censored data with covariate effect.

1. Introduction

To ensure the structural integrity of nuclear power plants, it is essential to predict the initiation time of PWSCC (Primary Water Stress Corrosion Cracking) [1-3]. For Alloy 182 welds, the prediction becomes more crucial than that for Alloy 600 base metal, since the crack growth rate of Alloy 182 weld was reported to be five times higher than that of Alloy 600 [2].

However, it is almost impossible to obtain a formula that can accurately predict the initiation time of cracking due to the complexity and large number of factors in the PWSCC initiation mechanism. Moreover, most laboratory