Asociación Argentina
de Mecánica Computacional

Resúmenes de Mecánica Computacional Vol II, pp. 167-167
A. Caggiano, G. Etse, P. Folino, M. Goldschmit, M. Pucheta, M. Storti (Eds.)
S. Corzo, J. Ramos Nervi (Issue eds.)
Buenos Aires, November 11-14, 2025

FATIGUE LIFE ANALYSIS OF A STEAM GENERATOR USED FOR NUCLEAR POWER PLANTS USING SUB-MODELING TECHNIQUE

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Keywords: steam generator, finite element analysis, fatigue life, digital twin.

Abstract. Over the past two decades, several crack failures have been detected in the weld area between the collector and the steam generator tank, requiring repair or replacement of the tank in several cases. Given the high economic risk of replacing a cracked steam generator, it may be advisable to develop an intelligent maintenance system that incorporates computer tools. This would enable the development of a techno-economic analysis system. Therefore, the aim is to build a simulation model of a critical steam generator to monitor its expected lifetime under operational loads. The model building also takes into account the requirements for creating a digital twin model based on a fatigue model to determine the lifetime under repeated thermal and mechanical loads. Consequently, a simplified model with low computational cost on the mid-surface of the steam generator has been constructed using shell elements. Based on the type of defects detected, it may be necessary to estimate the tank's lifetime for the propagation of the initial crack detected by monitoring, however, this requires a body model. Therefore, the sub-modelling technique has been used in the dangerous zone of the tested subassembly. This sub-model can be used to increase the lifetime estimation accuracy of the tank and reduce the computational demand to build a surrogate model. Crack propagation-based fatigue life calculations revealed that K_I, one of the stress intensity factors, exceeds the other two factors (K_{II} and K_{III}) by an order of magnitude at the investigated locations. This means that the stresses around the crack are dominated by the opening (tensile) crack mode, which the high internal pressure load can explain.

ISSN: 3072-7723 DOI: 10.70567/rmc.v2.ocsid8392