PROCEEDINGS PAPER

INFLUENCE OF AXISYMMETRIC NOTCHES ON THE LOW CYCLE FATIGUE LIFE OF A 316L STAINLESS STEEL IN THE FRAME OF INCEFA-SCALE PROJECT

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Abstract:

Stress concentration areas such as notches are common in nuclear plant components and have to be taken into account in fatigue life analyses. A high conservatism of current approaches and codes' design rules (such as Fatigue Strength Reduction Factor in ASME code) to evaluate fatigue lifetimes in such areas is expected. Therefore, in the frame of EU INCEFA-SCALE project, a test campaign has been performed to better understand and model the crack initiation and growth on notched specimens.

INCEFA-SCALE is a five-year project supported by the European Commission HORIZON2020 program. It aims to address the gap between the good Operational Experience of Nuclear Pressurized Water Reactor (PWR) plant and the difficulty in obtaining an acceptable environmental assisted fatigue assessment result. A reason for this discrepancy is that the assessment procedures described in codes and standards are based on laboratory test results that simplify and idealize the real conditions that plant components are subjected to. The assessment of components with stress concentrations areas are one of the main identified topics to fulfil this objective.

This paper gives an overview of the fatigue testing on notched specimens carried out to date and of the Finite Element Analyses undertaken to help the design of the test matrix and the results' analyses.

Two notch radii of 0.5 mm and 2 mm and a common value of diameter reduction (Δ=1.3) were chosen with the help of finite element elastic calculations. Stress concentration factor K_t values are approximately 4 and 2.6. Since fatigue results on notched specimens are supposed to be compared to uniaxial standard fatigue tests, choice was made to use comparable strain amplitude. Finite elements elastoplastic calculations were thus performed to evaluate the loads needed to achieve strain amplitudes of 0.3% and 0.6% at the notch tip. Indeed, load control was chosen for the fatigue testing to get a common control among all labs and ease the control on PWR rigs. Tests are planned in air and PWR environments to assess if a combined effect of stress concentration and primary water environment exists. First results show higher fatigue lives than the ones predicted by the NUREG/CR-6909, Rev. 1 mean air curve. However, the uncertainty of the strain at the notch tip is discussed as the effect of strain gradient and specimen diameter.

Keywords: notched specimens, environmentally assisted fatigue, PWR, features testing

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