

An analysis of notch sensitivity in the VHCF fatigue regime of S690 steel

Rita Dantas^{1,2,3*}, Michael Gouveia^{1,2}, Filipe G. A. Silva², Felipe Fiorentin^{1,2}, Abílio de Jesus^{1,2}, José A. F. O. Correia^{1,2,3}, Grzegorz Lesiuk⁴

¹University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal, rdantas@inegi.up.pt

²INEGI, Department of Mechanical Engineering, University of Porto, Portugal

³CONSTRUCT, Department of Civil Engineering, University of Porto, Portugal

⁴Department of Mechanics, Materials Science and Biomedical Engineering, Faculty of Mechanical Engineering, Wrocław University of Science and Technology, ul. Smoluchowskiego 25, PL-50370 Wrocław, Poland

S690 Steel

Notch effect

VHCF

Abstract Generally, the notch presence in a structural detail can be characterised by the stress concentration factor (k_t), or with more accuracy, by the fatigue stress concentration factor (k_f). The last concept can be defined as the ratio between the fatigue limit of a smooth specimen and the fatigue limit of a notched specimen, which implies the execution of an expensive and time-consuming experimental campaign. Thus, some authors propose different approaches of hot-spot, average-stress, stress-field-intensity or volumetric nature, to predict the fatigue life of notched specimens [1]. However, the notch effect in the very high cycle fatigue (VHCF) regime is not well characterised in literature, as well as the experimental procedure to test notched specimens in an ultrasonic fatigue machine. Consequently, this work aims to evaluate the notch effect in the fatigue behaviour of S690 steel and to study different approaches to predict fatigue notch life in very high-cycle fatigue regimes.

Therefore, an ultrasonic fatigue machine performed an experimental campaign with smooth and notched specimens of S690 steel (Fig.1 (right)). The specimens' different geometries were defined based on an analytical formulation established from the elastic wave theory and complemented with a finite element model, allowing stress amplitude analysis at the critical cross-section (Fig.1 (left)). It was concluded that S690 steel is extremely notch sensitive. Furthermore, the notch effect in fatigue life increases with the number of cycles and all specimens showed crack initiation at the surface.

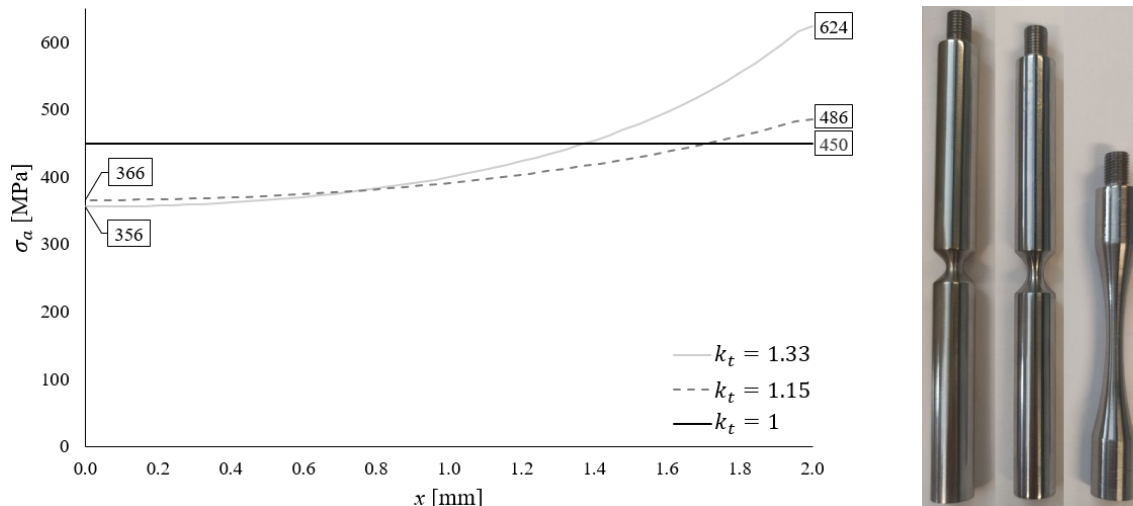


Figure 1 - Stress amplitude for different k_t along the critical cross section according to numerical model (left) and smooth and notched specimens analysed (right)

- [1] G. Qylafku, Z. Azari, and G. Pluinage, "On the fatigue failure and life prediction for notched specimens," *Mater. Sci.*, vol. 34, no. 5, pp. 17–26, 1998.