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# RESEARCH SUMMARY

## EFFECT OF SURFACE DEFECTS ON THE FATIGUE STRENGTH OF NODULAR CAST IRON RAILWAY BRAKE COMPONENTS

## INTRODUCTION

Discontinuities on the surface and the ones in the near-surface layer (shrinkage and gas porosities, sand drops, nonmetallic inclusions, high surface roughness) have a significant impact on the high-cycle fatigue strength of cast components. Due to their stress concentration effect in many cases they lead to the initiation of a detrimental the fatigue crack. The presence of various discontinuities is an unavoidable property of cast materials. The consideration of the real, non-ideal, geometry and material properties is therefore necessary in the fatigue assessment, since it fundamentally determines fatigue performance. The investigation of the fatigue phenomenon for the ferritic-pearlitic ISO1083/JS/500-7 nodular cast iron grade is at the center of the research program.

## RESEARCH AIM

The research aims to interpret the effect of defects, and then derive assessment methods for the consideration of surface discontinuities (Figure 1.) in the high-cycle regime.

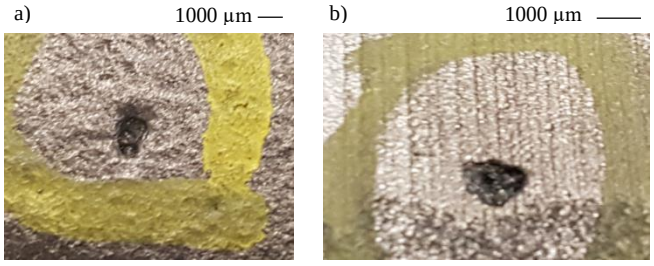


Figure 1. a-b. Surface discontinuities on nodular cast iron components.

In order to ensure industrial applicability, the developed methods aim to provide directly usable answers for the industrial quality inspection process.

## RESULTS

The Defect Stress Gradient approach originally developed by the research group by Professor Yves Nadot has been further developed during the course of this research, and important steps have been made to facilitate its industrial applicability. Allowable defect size maps (Figure 2.d) can be derived as FE-result fields for a given number of aimed service life, which had its first industrial application at the Knorr-Bremse Railway Systems Budapest in the summer of 2017. An extensive and unique database have been built for the ISO1083/JS/500-7 cast iron grade containing results for monotonic and cyclic material behavior, low- and high cycle fatigue considering the mean stress, structural and local stress gradient effects for test specimens and components and fracture mechanics testing. As an extension the research, investigations have been made related to a novel probabilistic approach, which deduces component strength from the survival distribution function of infinitesimal volumes.

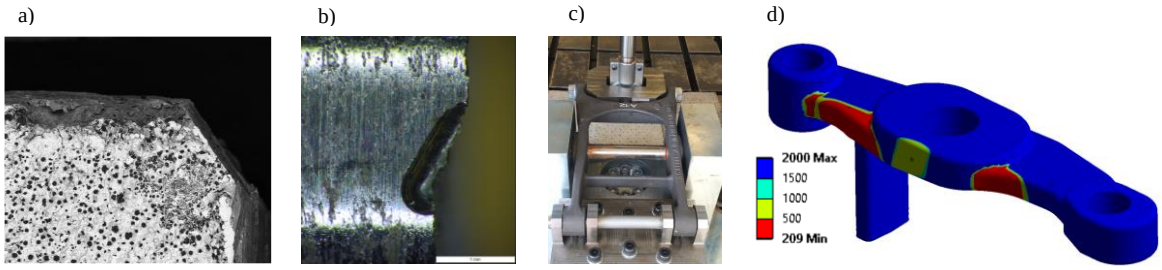


Figure 2. a) SEM image from a facture surface, crack initiation from casting defects, b) Fractured HCF specimen with artificial defect, c) Railway brake lever component testing, d) Allowable defect size map FE-result [$\mu m$].

# PUBLICATIONS

[1] M. Gróza, Y. Nadot, K. Váradi, Defect size map for nodular cast iron components with ellipsoidal surface defects based on the Defect Stress Gradient approach, International Journal of Fatigue, Volume 112, 2018, pp 206-215.

[2] M. Gróza, K. Váradi, Fatigue design of ferritic-pearlitic nodular cast iron components with surface discontinuities, Strojniski Vestnik/Journal of Mechanical Engineering, Volume 64, 2018, pp 373-382.

[3] M. Gróza, K. Váradi, Total fatigue life analysis of a nodular cast iron plate specimen with a center notch, Advances in Mechanical Engineering, Volume 9, Issue 12, 2017, pp 1-11.

[4] Gróza M., Váradi K., A feszültségmező analitikus számítása felületi hibák környezetében Eshelby Egyenértékű Zárvány Módszerével, A Gépipari Tudományos Egyesület Műszaki Folyóirata, 2016/5-6. LXVII. évfolyam, pp. 94-98, 2016.

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[6] M. Gróza, Y. Nadot, K. Váradi, Fatigue design of cast iron components with surface discontinuities, MATEC Web of Conferences, 2018.