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To what extent may we accept manufacturing-related microscopic defects in cast steel?

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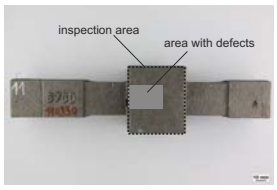
Introduction

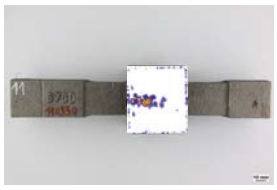
The occurrence of process-related discontinuities and minor flaws in the interior of cast steel cannot be fully avoided during the manufacturing process. Obviously, these microscopic defects affect the material properties of the casting near locations where they occur. However, their very occurrence does not necessarily deteriorate the stability of the entire casting element. Unfortunately, current testing approaches do not integrate a reliable and customized case-by-case quality assessment. Consequently, manufacturers usually apply a general, rather expensive and resource-intensive finishing of cast steel components. Our research is aimed at making best use of the available material and avoiding such potentially unnecessary finishing steps. For this purpose, nondestructive testing (NDT) is combined with finite element based modeling allowing us to estimate the mechanical behavior of cast steel in a reliable way.

APPROACH & RESULTS

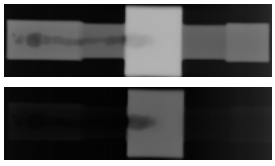
Application and qualification of innovative NDT methods



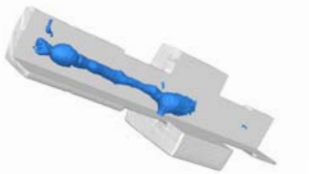
US contact technique – hand scanning
Assessment on the basis of A-Scans
according to standard (with classification)



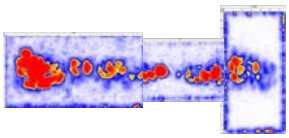
US immersion technique – automated scanning
Assessment on the basis of B- and C-Scans
(sections through a reconstructed volume)



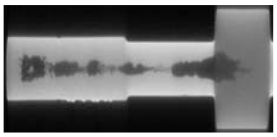
Radiographic testing



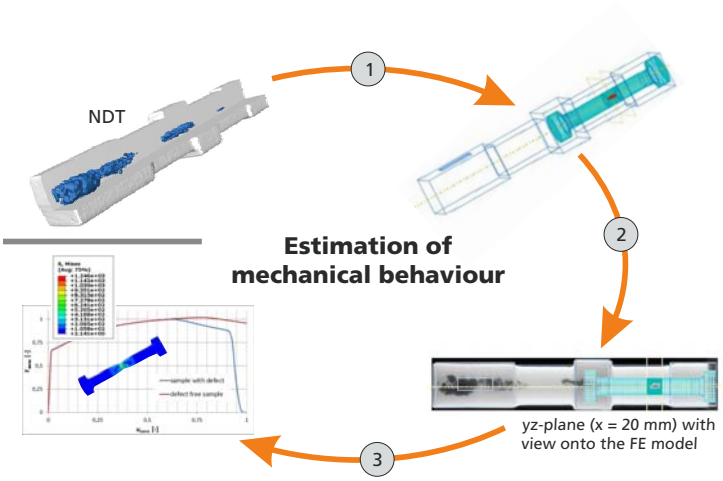
3D high-energy x-ray computed tomography



Ultrasonic FMC measurements C-Scan

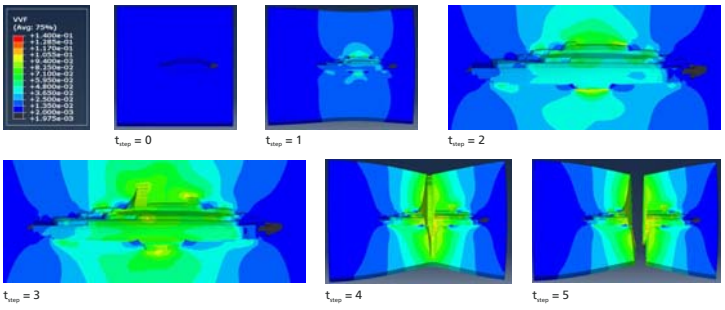


High-energy x-ray computed tomography
yz-plane



1 – Transfer of NDT information to a model suited for FE simulation (data mapping)
2 – Calibrated material parameters for defect free samples (Gurson material model)
3 – Calculation of failure behaviour of tensile specimen with calibrated material parameters from defect free specimen parts and defect affected parts (from NDT)

Development of damage parameter: $VVF_F = 0{,}14$



Acknowledgments

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