Aalto University
School of Engineering

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Defect tolerance as the basis of fatigue assessment

Title of the dissertation	The influence of interacting small defects on the fatigue limit of steels
Contents of the dissertation	Fatigue means the degradation of material's strength properties under repeated loading. The reason for the degradation is small microscopic cracks that nucleate from material defects. Eventually, the growth of cracks results in a complete fracture of the component. Since these small cracks initiate from natural defects in a material, it becomes important to analyze the size distribution and proximity of the defects. The defects result from normal manufacturing and steel-making processes. Therefore, they cannot be completely avoided. Although the influence of a single crack-like defect on the fatigue strength has been comprehensively examined, more detailed investigations are needed on the interaction of defects. The current defect interaction guidelines do not consider the strength properties of materials. This thesis examines the influence of interacting small defects on the fatigue strength of different steel grades. The results clearly demonstrate that defects in close proximity interact with each other and it can reduce the fatigue strength significantly. The magnitude of interaction is mostly dependent on the hardness and the microstructure of steel. In addition, the geometry of the initial defect has an impact on the fatigue limit of high strength steels. In order to consider defect geometry effect, a geometry parameter needs to be included into the defect interaction guidelines. To consider the effect of defect geometry, a finite element -based approach was developed. The proposed method allows the analysis of various defect configurations that have arbitrary three-dimensional shapes.
Field of the dissertation	Mechanical Engineering
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