DFG project Schm 746/127-1

Hybrid shaft-hub interference fit assembly with ceramic hub – Experiment and Simulation of Deterioration on steel-ceramic interface

Duration of project: 3 years
Start of project: 01.12.2013
End of project: 30.11.2016

Aims:

In many technical applications which place high demands on the materials in service, only high performance ceramics are suitable because of their low density, high hardness, excellent resistance to temperature and chemical & abrasive media. The future demands ceramic machine elements with safe designs. The application of ceramics in machinery requires suitable connectivity to adjacent components often in the form of shaft-hub connections for which an interference fit is the most suitable to avoid stress peaks and cause sudden failure. The aim of this project is to investigate the fail-related processes in terms of internal stresses and microstructure of joining partners in the interference fit shaft-hub connections to develop a safe and economical design recommendation. With the help of simulation models backed by corresponding experimental results, expensive and time-consuming tests can be avoided in the future.

Procedure:

Some preliminary works have already been done by the IKTD and IMWF with their previous understanding of the hybrid press connections through various dissertations and successful industrial implementation.

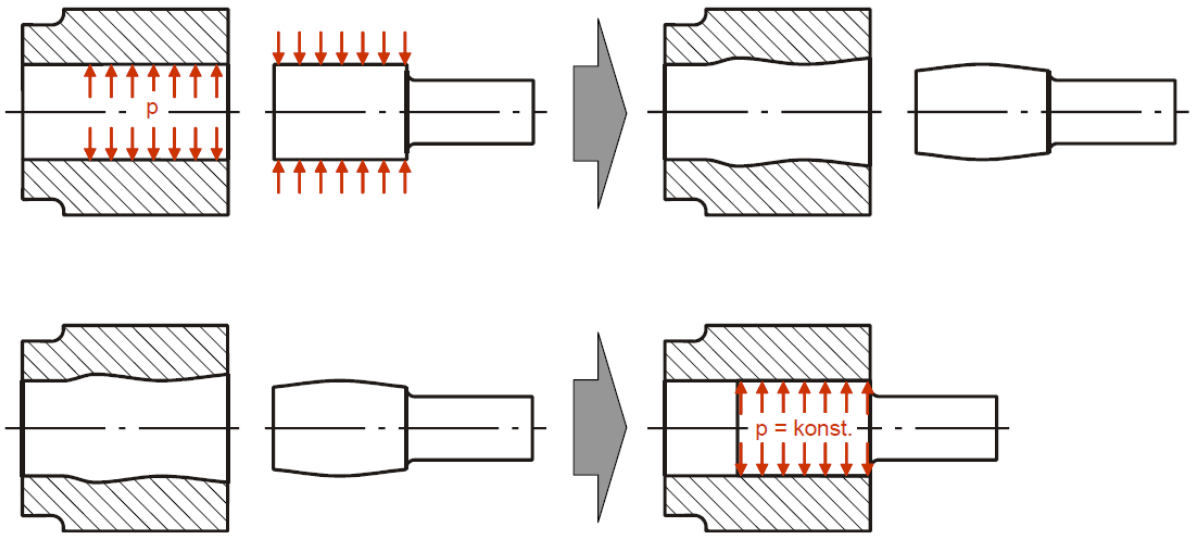

Fig 1: Principle of stress homogenization

Initially it is found that in the shaft-hub connections there is a stress peak in the hub edges. So if a correction is made to the hub edges the stress can be homogenized throughout the shaft-hub interface and thus fracture can be avoided. The correction is calculated through finite element methods and is usually in the range of few microns but for the sake of illustration the correction is exaggerated in fig 1. Note the absence of stress peaks at the hub edges after the homogenization in fig 2.

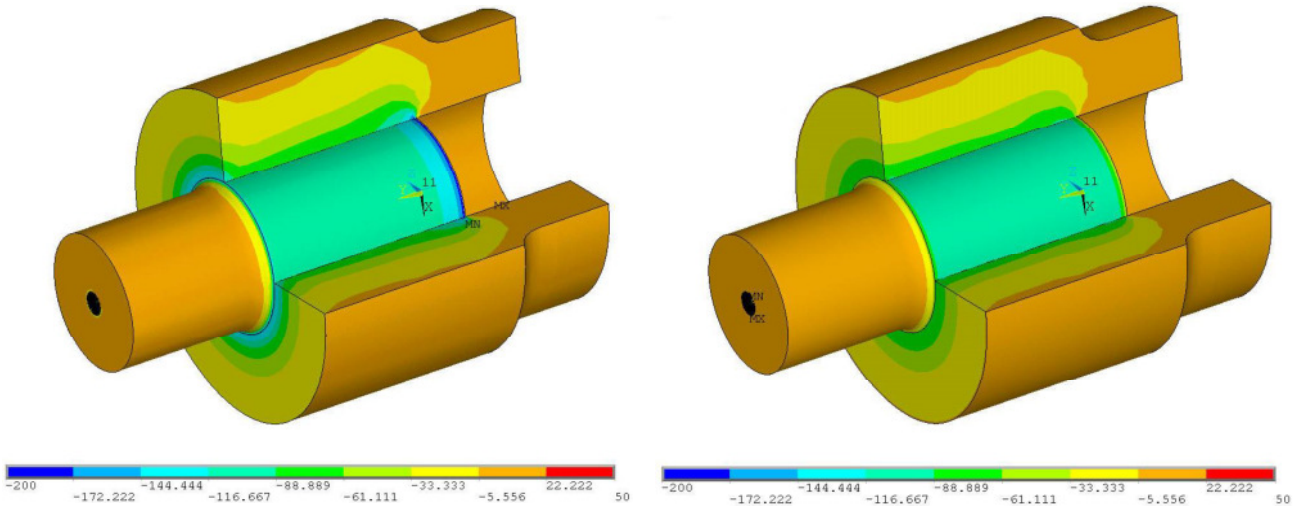

Fig 2: The stresses before and after homogenization of the shaft-hub interference fit.
Results from Martin Blacha, IKTD (PhD-thesis, University of Stuttgart, 2009)

The IMWF already has data of the materials in the areas of

- Strength
- Fatigue behavior
- Strength theories
- Transferability (Übertragbarkeit)
- Micromechanical Modelling

The work program is divided into two main sections:

- Production
  - Residual stresses in the preparation and joining
  - Microstructure and damage in the preparation and joining
- Operating stresses
  - Effects of residual stresses during operation
  - Microstructure and damage during operation

The planned project done with cooperation between the two institutions, IKTD & IMWF, only tests under torsion as of now, since it has the most practical application. Therefore a complete interpretation cannot be given at the moment, however a design recommendation can be made.

Partners

In this project, we work together with

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