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## **Internship/Bachelor/Master Thesis**

### **Topic: FEM - Modelling of fabric-reinforced semi-finished products in air springs of railway vehicles**

Air springs are highly stressed, complex products that play a crucial role in rail vehicles in terms of safety and comfort. The mechanical properties of the air bellows are determined by the combination of strength carriers and rubber material. The modelling of the air spring bellows will be examined in detail in the tendered thesis and will lead to a reliable prediction of the spring stiffnesses.

In this task, different approaches for modelling multilayered rubber sheets with reinforcements are to be investigated. An existing experimental setup for the measurement of stiffness of the structural composite is used to validate the model approach. Based on the recorded data, the model and its parameters will be calibrated. Suitable models and data sets are transferred to the air spring model and compared with measurements of the overall structure.

The topic is adaptable to experimental or continuum mechanical aspects, depending on skills and interest. In any case, the following requirements are necessary:

- Very good knowledge of mechanics
- Basics of the Finite Element Method
- Basic knowledge of programming in Python or Matlab
- Basic knowledge of measurement technology

Furthermore, the following fields must be worked on, individual focal points in individual fields are possible:

- Handling Abaqus and Abaqus/CAE
- Continuum mechanics with a focus on rubber elasticity
- Modelling of multilayer fabric reinforcements
- Creation of user subroutines in Abaqus
- Preparation and evaluation of measurement data
- Methods for parameter identification
- Improvement of measurement methods for stiffness measurements
- Improvement of the test specimen for model validation
- Influence of the manufacturing process of the air spring on the mechanical model

Ideally, an internship is first carried out to get to know the product and the preceding works. Model validation based on existing models for the existing test setup. This is followed by the preparation of a thesis in which jointly developed ideas for the improvement of existing modelling approaches are implemented and validated.

Dr.-Ing. Jens Jagusch