PERMAS

CONTACT WITH STATIC AND SLIDING FRICTION

VOITH TURBO using PERMAS contact analysis: Keeping sticking and slipping under control!

Developing sophisticated press fits, the engineers of Voith Turbo GmbH in Heidenheim, Germany, rely on PERMAS already during the design phase: torque, centrifugal force, static and sliding friction are considered in the simulation. Friction forces, sliding paths, areas of sticking and sliding as well as stresses and displacements allow detailed statements on the behavior of the construction during assembly and during operation.

PERMAS considers important effects:

LOAD HISTORY

The behavior of an assembly in which sliding appears, is crucially dependent on the sequence of the applied loading.

STICK-SLIP

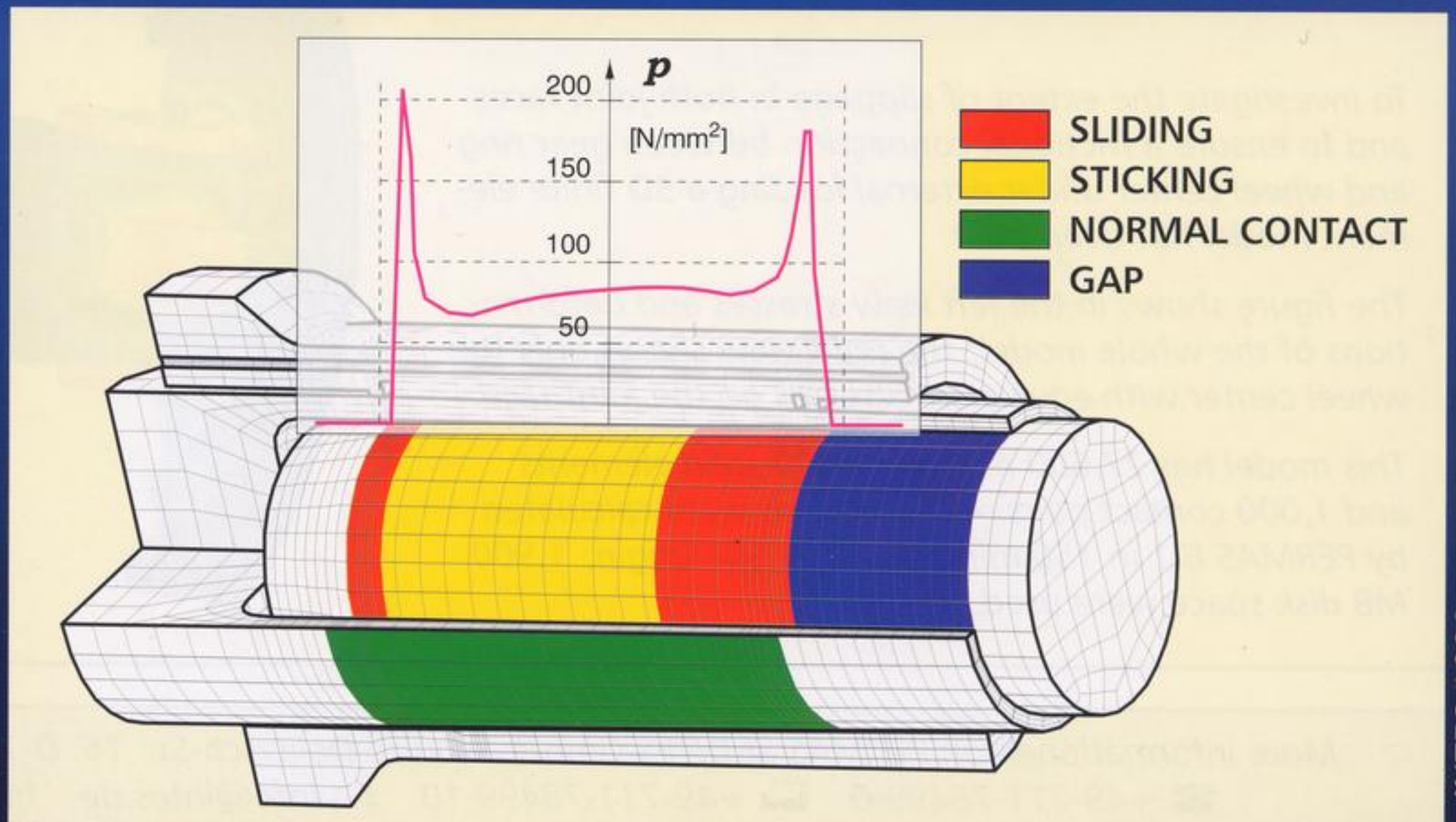
Slipping contact regions can return to sticking when the load is changed or removed.

RELAXATION

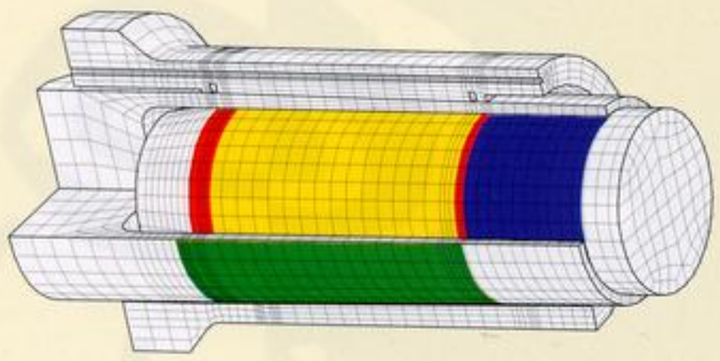
Tangential stresses in the joint surface that occur during the assembly of a press fit, disappear gradually.

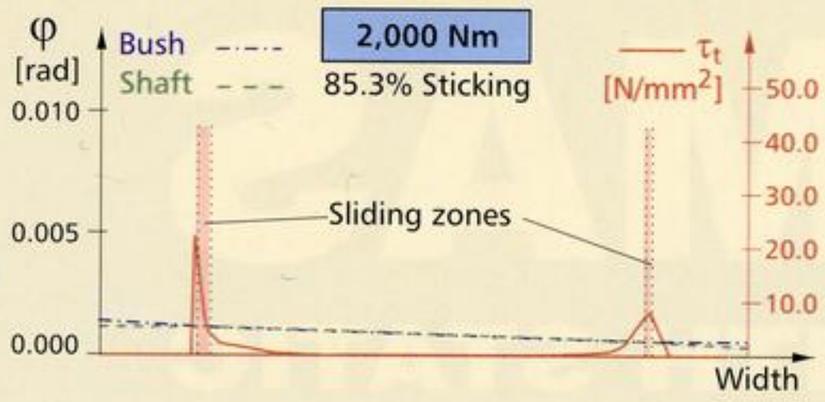
This hydraulically prestressed coupling from the product section Transmit of Voith Turbo GmbH Antriebstechnik was modeled using solid elements and contact with Coulomb friction. Load history, relaxation and local stick-slip effects were taken into account.

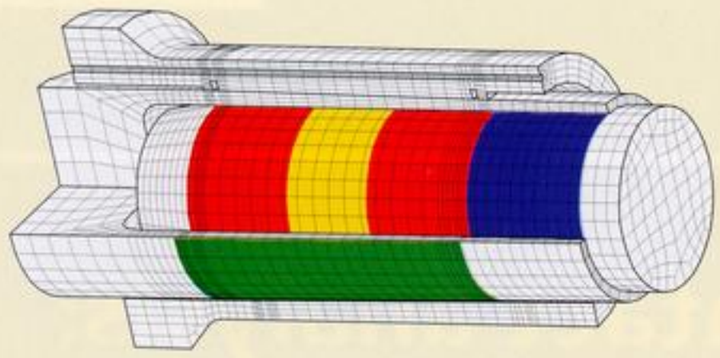
This figure shows contact and friction areas as well as the distribution of the contact pressure directly after the assembly without external loads and relaxation.

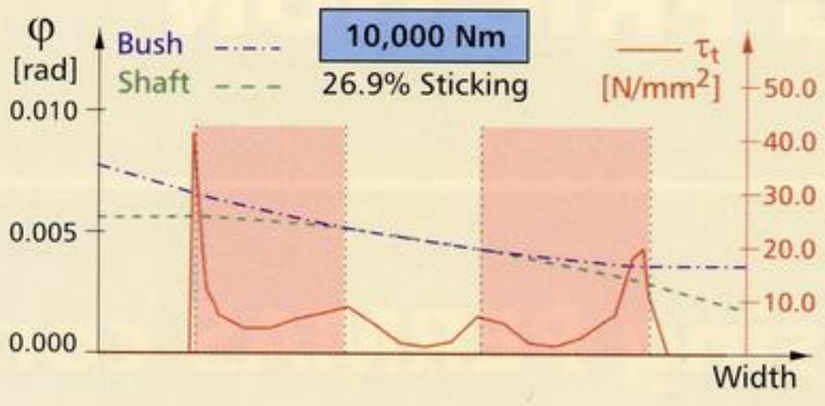


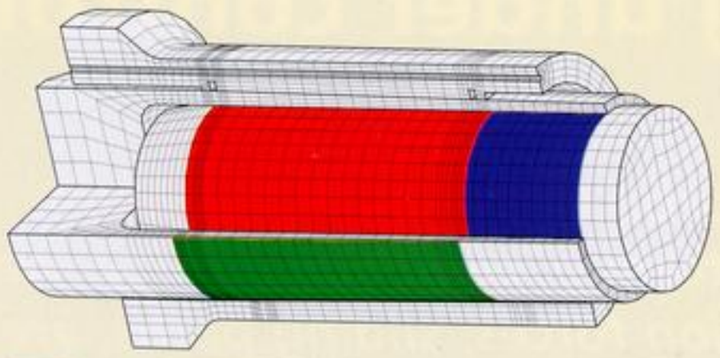
Picture by courtesy Voith Turbo GmbH & Co. KG, Heidenheim, Germany

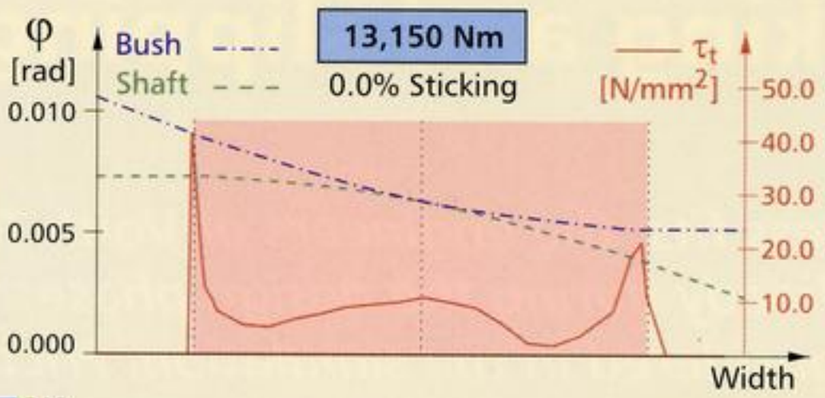










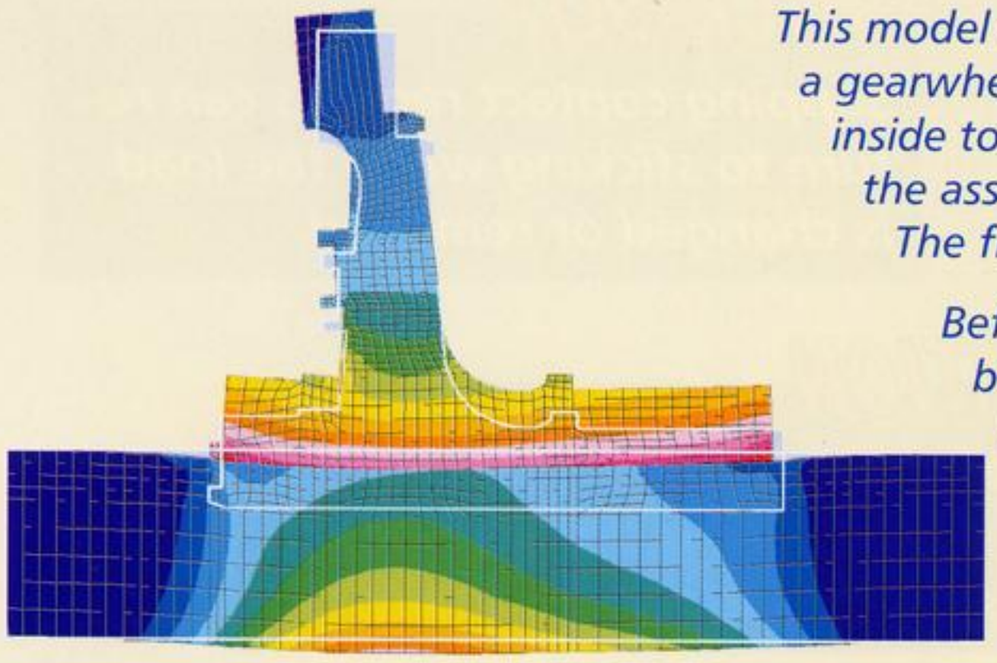


SLIDING STICKING NORMAL CONTACT GAP

This VOITH coupling transmits torque by friction. It is assembled from inside to outside by a shaft, a bush and a hub. The connection between bush and hub was modeled as normal contact, the connection between bush and shaft as contact with friction.

The figure shows for increasing load levels the contact state, the percentage of sticking regions, the tangential traction stress τ_t as well as the twisting angles of hub and shaft. The difference of the twisting angles can serve as a rate for a possible frictional corrosion.

The simulation shows the well-known efficiency of PERMAS: The model with 24,000 nodes, 19,000 solid elements and 2,200 contact pairs was calculated by version 6.1 with 37 load steps in only 100 min. total elapsed time, requiring 1,260 MB disk space on an IBM RS-6000/397.



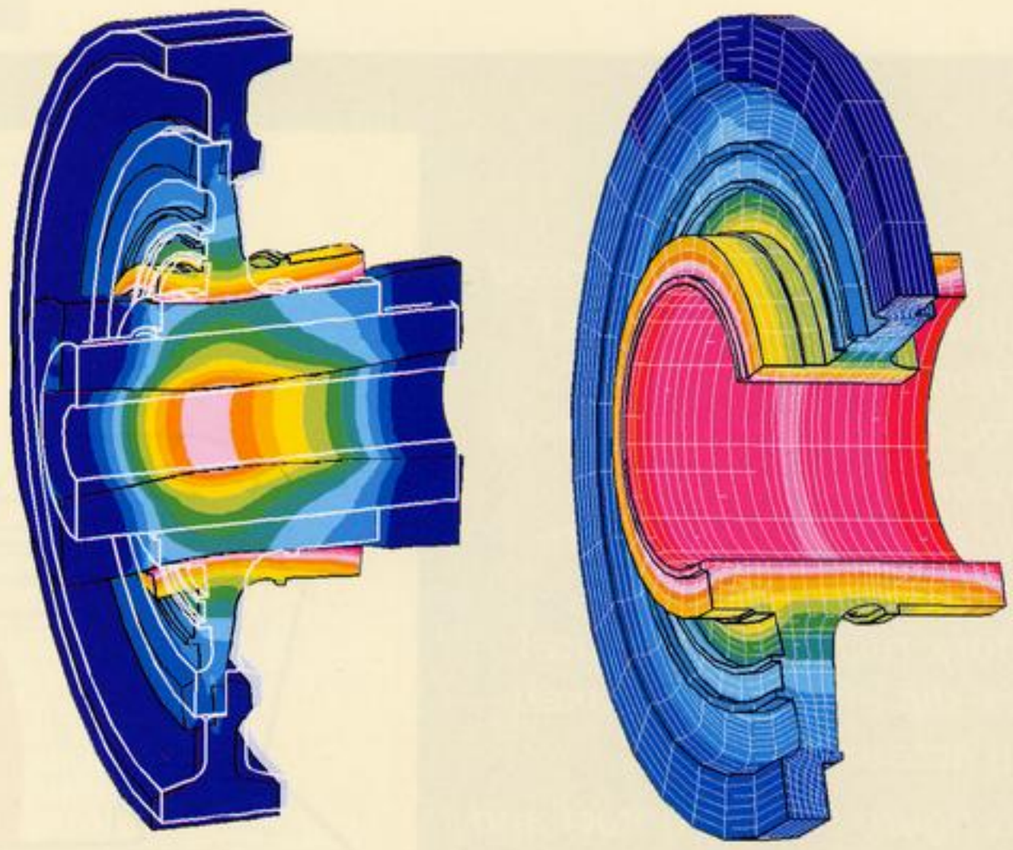
This model of Voith Turbo GmbH shows the connection of a shaft and a gearwheel from an actuation of a rail car. It is assembled from inside to outside by a shaft, a wheel center and a gear ring. During the assembly, first the wheel center is shrinked onto the shaft. The figure shows the resulting deformations and stresses.

Before the gear ring is flanged to the wheel center with bolted connections, the joint area of the wheel center must be faced to attain a plane flange face.

To investigate the extent of slippage in both joint faces and to ensure a frictional connection between gear ring and wheel center under external loading a 3D finite element model has been built.

The figure shows in the left view stresses and deformations of the whole model; the right view shows only the wheel center with equivalent stresses on the joint face.

This model has 27,600 nodes, 22,900 solid elements and 1,000 contact pairs. 43 load steps were calculated by PERMAS 6.1 in 150 minutes on an SGI Origin; 1,900 MB disk space were used.



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