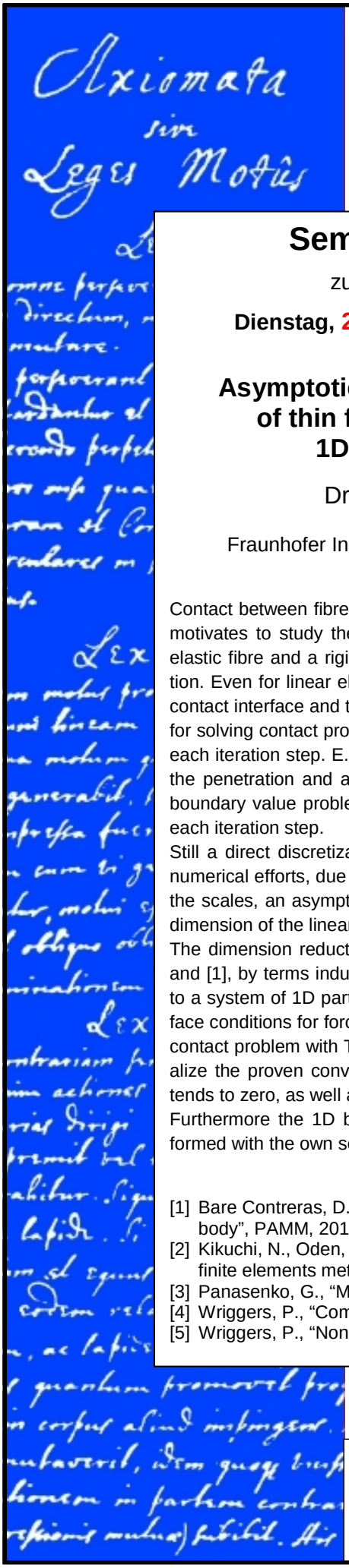

Seminar über Fragen der Mechanik

zu folgendem Vortrag wird herzlich eingeladen

Dienstag, 22.05.2012, 16:00 Uhr, Egerlandstr. 5, Raum 0.044

Asymptotic dimension reduction for linearized contact of thin fibers and simulation of textiles based on 1D models including large deformation

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Contact between fibres has an influence on the mechanical properties of technical textiles. This motivates to study the contact between thin elastic fibres. The unilateral contact between an elastic fibre and a rigid body is modelled by a Signorini problem with the Tresca friction condition. Even for linear elastic materials, contact problems are non-linear because of the unknown contact interface and the non-smooth frictional functional. However, known numerical algorithms for solving contact problems, are based on some iterative algorithms, solving linear problems on each iteration step. E.g. one of the known methods (see [2] or [4]) is based on a penalization of the penetration and a regularization of the friction contribution and leads to a linear elasticity boundary value problem with Robin-type boundary condition at the known contact interface on each iteration step.

Still a direct discretization and numerical solution of this 3D Robin problem requires too high numerical efforts, due to the fact that the fibres are thin and long. To overcome this difference of the scales, an asymptotic approach with respect to the relative thickness is used to reduce the dimension of the linear elasticity boundary value problem with additional Robin condition.

The dimension reduction is performed by extending a standard asymptotic expansion, see [3] and [1], by terms induced by the contact conditions. This asymptotic dimension reduction leads to a system of 1D partial differential equations of second and fourth order with Robin-type interface conditions for forces and moments. These 1D equations are reinterpreted as a 1D Signorini contact problem with Tresca friction. Furthermore, some numerical examples are shown to visualize the proven convergence of the 3D problem to the 1D problem as the scaling parameter tends to zero, as well as to illustrate the mechanical interpretation of the limit equations.

Furthermore the 1D beam model is extended to large deformations and simulations are performed with the own software-tool FiberFem.

[1] Bare Contreras, D.Z., Orlik, J., “Asymptotics for a thin elastic fiber in contact with a rigid body”, PAMM, 2011
[2] Kikuchi, N., Oden, J.T., “Contact problems in elasticity: A study of variational inequalities and finite elements methods”, SIAM, USA, 1988
[3] Panasenko, G., “Multiscale modeling of structures and composites”, Springer, 2005
[4] Wriggers, P., “Computational contact mechanics”, John Wiley & Sons, Ltd, 2002
[5] Wriggers, P., “Nonlinear Finite Element Methods”, Springer, 2008

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