On the spatial nonsmoothness of beam-to-beam contact problems: analytical and numerical approaches

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In recent years, the interest in the simulation of systems with flexible slender structures experiencing contact has grown significantly. This talk addresses the spatial discontinuities which may appear in frictionless beam-to-beam contact problems.

This spatial nonsmoothness is first illustrated through a simple analytic example of a static cantilever beam pushed onto a rigid wall [1]. In the case of an Euler-Bernoulli beam, it is shown that the distributed contact force is equal to the load all along the contact region except at the boundary where a point load appears. On the contrary, for a Timoshenko beam, a distributed reaction force takes place and decays exponentially from the first contact point, but there is no point load. The rate of decay depends on the magnitude of the shear deformability.

Then, the development of a suitable spatial discretization scheme is addressed. Following a mortar formulation [2], the non-penetration constraint is enforced in a weak sense using an augmented Lagrangian approach. The choice of the shape functions for the Lagrange multiplier field plays an important role in the numerical procedure.

Finally, the discussion is extended to the dynamic case which additionaly involves temporal discontinuities such as velocity jumps and impacts. The nonsmooth generalized-α scheme [3] is selected for the time discretization. We show that the combination of the mortar approach and the NSGA offers an appropriate framework for the modelling of dynamic contact interactions among beams.

References

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