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The influence of beam kinematic assumptions in a beam contact benchmark

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We present a benchmark to help validating simulation codes for contact problems involving beams and discuss the influence of different kinematic hypotheses on the solution. Closed form expressions are derived and the comparison is made with a finite element implementation that uses the mortar method for enforcing the contact constraints [1]. The test case consists in a semi-infinite cantilever beam subjected to a constant distributed load and experiencing frictionless contact with a straight rigid substrate. It is shown that in the case of the Euler-Bernoulli beam the distributed contact force is equal to the load along the contact region except at the boundary where a point load appears. On the contrary, the rigid substrate exerts a fully distributed load on the Timoshenko beam which decays exponentially from the first contact point and tends towards the applied load. The speed of decay depends on the magnitude of the shear effect. For both models the distributed contact force is discontinuous. Moreover, whereas in the first case the transverse shear force is discontinuous, it becomes continuous when allowing for shear deformation. It is shown that the numerical value of the total contact force converges to the analytic solution when the finite element mesh is refined. Our observations are consistent with the results found in [2, 3] in other beam contact problems. Richer beam models, that allow for transverse normal deformation, would lead to continuous distributed contact forces.

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