# A planar nonlinear Euler-Bernoulli beam element using B-Spline interpolation functions for the analysis of pantographic sheets

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The Euler-Bernoulli assumption, demanding the fibers of the cross sections of the beam to remain orthogonal with respect to its centerline, allows for a formulation using the motion of the centerline only. In this formulation, the rotation of the cross section is specified using the components of the tangent vector to the centerline. Consequently, the change in the rotation along the beam coordinate, required in the internal strain energy, is described by an effective curvature being a function of first and second derivatives of the centerline. Thus, a finite element analysis of such a beam formulation requires at least $C^1$-continuity for the interpolation functions. However, even higher continuity will sometimes lead to better convergence behavior. An interpolation which allows for an increase of the continuity for a given finite set of discretization coordinates are B-Spline functions, frequently used in isogeometric analysis. Based on such B-Spline interpolation functions, in this paper a planar Euler-Bernoulli beam element is presented which allows for large displacements and rotations as well as for large axial deformations.

One possible application of these beam elements lies in the static and dynamic analysis of pantographic sheets. In the reference configuration, pantographic sheets consists of two orthogonal arrays of straight fibres interconnected by interal pivots. It is more than obvious to model these fibres using beam elements. In this paper, we intend to give some insights into the numerical model with especial focus on the treatment of the transition conditions which allow for jumps in the axial strain at the pivots, i.e. the points of interconnection between the two arrays of fibres. Among others some preliminary static results are shown.