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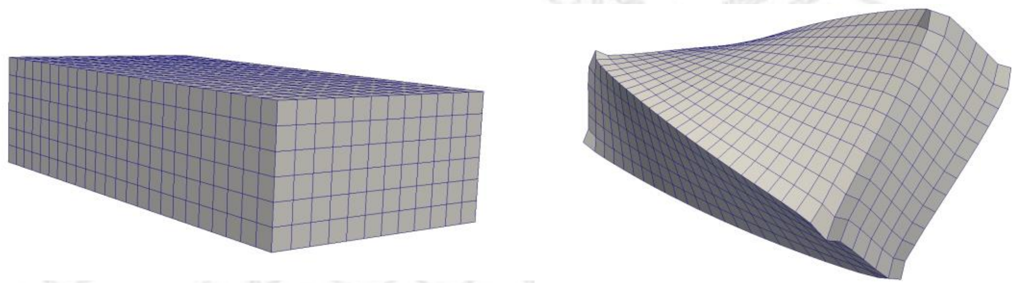
Coupling beams and continua: novel variational principles and numerical methods

A common problem in Structural Engineering practice is the approximation, using finite elements or a similar technique, of joints between beams and continuum regions. For lack of a unifying theory that couples these bodies with dissimilar kinematics, ad hoc solutions, typically based on multipoint constraints, are frequently employed in practical calculations.

In this talk we will present a new model that describes the coupled behavior of linear and nonlinear beams linked with continua. The model is based on a novel variational principle that weakly imposes the compatibility of kinematics at the interface surface. Formulated independently of any discretization, the model is the first of its kind and can be employed together with interpolatory and non-interpolatory Galerkin methods. Moreover, at least in the linearized setting, the resulting boundary value problem can be proven to be well posed.

Finite element approximations based on the new variational principle will be shown next. The solutions not only exhibit the compatibility of kinematics between beams and solids but allow, in contrast with existing methods, the warping of the connected surfaces when subject to torsion. Remarkably, in this case, and without additional information, Saint-Venant's solutions are recovered as being the most favorable from the energetic point of view.



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