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MESHFREE METHODS FOR SHEAR-DEFORMABLE STRUCTURES BASED ON MIXED WEAK FORMS

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Similarly to the finite element method, meshfree methods must be carefully designed to overcome the shear-locking problem when discretising the shear-deformable structural theories.

Many successful treatments of shear-locking in the finite element literature are constructed through the application of a mixed variational form, where the shear stress is treated as an independent variational quantity in addition to the usual displacements. Because of its sound mathematical underpinnings this is the methodology I have chosen to solve the shear-locking problem when using meshfree basis functions.

In this talk I will discuss the mathematical origins of the shear-locking problem and the applicability of the celebrated LBB stability condition for designing well-behaved mixed meshfree approximation schemes.

I will show results from two new formulations that demonstrate the effectiveness of this approach. The first method is a meshfree formulation for the Timoshenko beam problem that converges to a classic inf-sup stable finite element method when using Maximum-Entropy basis functions.

The second method is a generalised displacement meshfree method for the Reissner-Mindlin problem where the shear stress is eliminated prior to the solution of the linear system using a local patch-projection technique, resulting in a linear system expressed in terms of the original displacement unknowns only. Stability is ensured by using a stabilised weak form which is necessary due to the loss of kernel coercivity for the Reissner-Mindlin problem.