The Lumped Stress Method and the equilibrium of masonry structures

Maurizio Angelillo*

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Abstract

The Lumped Strain Method is a variational approximation for the equilibrium of isotropic elastic plates (originally proposed by Glowinsky and studied by Cesare Davini in the 90ties) for which the biharmonic problem can be approximated with piecewise linear finite elements. The qualitative convergence of the method was shown by Davini & Pitacco, in the context of Gamma-convergence, in 1997. With A.Fortunato & F.Fraternali the approach was extended to the Airy stress formulation of the plane problem of anisotropic linear elasticity and quantitative convergence of the method proved in the context of mixed methods. Apart from the speculative interest for a new approximation technique for elastic problems, the method, when applied to the approximation of the Airy's stress function, offers a convergent method to approximate an elastic continuum with a truss structure. In this talk I show how this truss structure can be created by introducing a special "interaction" energy and the problem of approximation reformulated in terms of axial forces and nodal displacements. In this way the restrictions to simply connected plane bodies with zero body forces is overcome and the method can be used to approximate general 3D problems, obtaining the approximate solution by minimization of the complementary energy with the node equilibrium constraints. The main feature of the method is that any approximate solution, rough as it can be, is balanced and produces, without any integration, approximate nodal displacements. The convenience of applying the method to masonry-like structures is discussed.

*University of Salerno, Italy. E-mail: mangelillo@unisa.it