The polygon finite element approach: From linear to nonlinear structural analysis

***†Mahmood Jabareen[1]**

[1]Faculty of Civil and Environmental Engineering. Technion - Israel Institute of Technology, Haifa 32000, Israel

*Presenting author: cvjmah@technion.ac.il
†Corresponding author: cvjmah@technion.ac.il

Abstract

The polygonal finite elements method has been drawing increasing attention during the last 15 years for modeling the response of structures. In comparison to the standard finite elements, polygonal finite elements offer greater flexibility in meshing arbitrary geometries and better description of certain materials (e.g. granular materials). On the other hand, the disadvantages of the polygonal finite element method loses the sparsity structure of the stiffness matrix and the need for a higher order numerical integration quadrature scheme to achieve high accuracy. Unlike the traditional finite element method, the construction of the shape functions in polygonal finite elements method is different. Thus, a number of approaches for constructing the shape functions for polygonal finite elements were proposed. Among these approaches are the Wachspress shape functions, which are rational interpolation functions providing C0 continuity. The generalized barycentric coordinates, the Laplace based coordinates and the maximum entropy coordinates are other approaches for constructing shape functions.
With regards to applications, the polygonal finite element method has been applied in modeling polycrystalline ferroelectrics since crystal grains can be idealized as polygons. Recently, the polygonal finite element method has been extended and combined with higher shear deformation theory for modeling the static and the free vibration analysis of laminated composite plates. Also, it has been applied for crack growth simulation, where a local polygonal mesh strategy is performed employing polygonal finite element method to model the crack propagation.
In the present study, a review on the development of the polygonal finite elements method will be presented. Then, it will be extended for modeling nearly incompressible materials that undergo large deformations. Some examples that demonstrate the removing of the volumetric locking will be presented.

Keywords: **Polygonal finite elements; mixed formulation; large deformations; volumetric lucking**