Accepted Manuscript

A low order virtual element formulation for finite elasto-plastic deformations

P. Wriggers, B. Hudobivnik

PII: S0045-7825(17)30638-2
DOI: https://doi.org/10.1016/j.cma.2017.08.053
Reference: CMA 11598

To appear in: *Comput. Methods Appl. Mech. Engrg.*

A low order virtual element formulation for finite elasto-plastic deformations

P. Wriggers[1] and B. Hudobivnik [1]
[1] Institute for Continuum Mechanics, Leibniz Universität Hannover

e-mail: wriggers@ikm.uni-hannover.de

Abstract

The virtual element method has been developed over the last decade and applied to problems in elasticity and other areas. The successful application of the method to linear problems leads naturally to the question of its effectiveness in the nonlinear regime. This work is concerned with extensions of the virtual element method to problems of finite strain plasticity. Low-order formulations for problems in two dimensions, with elements being arbitrary polygons, are considered. The formulation is based on minimization of an incremental energy expression, with a novel construction of the stabilization energy for elasto-plasticity. The resulting discretization scheme is investigated using different numerical examples that demonstrate efficiency, accuracy and convergence properties. [a]

[a] This contribution is dedicated to our friend and exceptional scientist Tinsley Oden on behalf of his 80^{th} birthday.

Keywords: virtual element method, VEM, stabilization, finite strain plasticity.

1 Introduction

The virtual element has proven to be a competetive discretization scheme for meshes with highly irregular shaped elements that even can become non-convex. So far most applications of virtual elements where related to linear elastic deformations, see examples of the method by [1] and [2]. Stabilization procedures for the virtual element method, well known from the work of [3] for finite elements, are decribed in [4] for linear Poisson problems. The use of VEM for nonlinear problems has been discussed recently in [5] for inelastic materials at small strains and in [6] and [7] for hyperelastic materials at finite deformations.

The structure of the VEM typically comprises a term in the weak formulation or energy functional in which the quantity φ_h, here deformation, being sought is replaced by its projection $\Pi\varphi_h$ onto a polynomial space. This results in a rank-deficient structure, so that it is necessary to add a stabilization term to the formulation, see [8], [1] and [6], where in the latter the scalar stabilization parameter of the linear case was replaced by