

Abstract

Discontinuous Galerkin methods for elastoplasticity

Author: Diego Romagosa Sánchez-Monge

Supervisor: Dr. G.N. Wells

UPC supervisor: Dr. Antonio Rodríguez-Ferran

Commercial finite element packages using traditional continuous Galerkin finite element (cG) method are capable of predicting the elastoplastic behavior of structures. However there are certain cases where traditional methods face difficulties. For consistent implementation of thin Poisson-Kirchhoff plates, shape functions require C^1 continuity. This is however met by few, if any, plate element and the results obtained for these are not completely satisfactory. An alternative is to use continuous C^0 elements and impose the continuity of slope weakly. This procedure is known as discontinuous Galerkin (dG) finite element method. Unlike the traditional cG, dG methods do not require continuity of the approximate functions across the interelement boundary. Instead, in this case, C^1 continuity is enforced weakly by adding a term that penalizes the jump in the normal derivative. This weakly enforcement of continuity in displacement or normal derivative makes it possible to use spaces of discontinuous piecewise polynomials to solve numerous problems. This makes dG methods ideally suitable for h - and p -adaptivity, as well as for dealing with non-matching grids.

In this master's thesis we analyze two different discontinuous Galerkin methods for elastoplastic problems. These are the interior penalty method and the non-symmetric discontinuous Galerkin method. However the existing literature is based exclusively in a linear elastic behaviour. Little has been done assuming plastic behavior for the different dG methods, making it difficult to exploit the explained beneficial properties of the more general elastoplastic case.

The work is therefore divided in mainly two parts. First, following the existing literature, an analysis of the behavior and properties in the elastic case of the two mentioned dG methods is done. In the second part of this thesis the formulation for the elastoplastic case is done for both the IP and the NS method. Due to a simpler formulation of the non-symmetric method the extension to the elastoplastic case is straightforward, resulting in a method with similar properties if compared to the elastic case. However the extension of the interior penalty method becomes ambiguous, and can only be carried out if some simplifications are assumed.