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C. Weißenfels, P. Wriggers

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Stabilization Algorithm for the Optimal Transportation Meshfree Approximation Scheme

C. Weißenfels · P. Wriggers

Abstract Meshfree approximation schemes possess a high potential in computer aided engineering due to their large flexibility. Especially the tremendous progress in processor technology within recent years relativizes the increase in computation time due to the inherent search algorithm. Nevertheless meshfree approximation schemes are still faced with some challenges, like imposition of Dirichlet boundary conditions, robustness of the algorithm and accuracy. The recent developed Optimal Transportation Meshfree (OTM) method seemed to overcome most of these problems. In this paper the OTM solution scheme is combined with a standard search algorithm in order to allow a simple and flexible computation. However this scheme is not stable for some examples of application. Hence an investigation is conducted which shows that the reason for this instability is due to underintegration. Based on this investigation a remedy to stabilize the algorithm is suggested which is based on well known concepts to control the hourglass effects in the Finite Element Method. In contrast to the original publication, the OTM algorithm is derived here from the principle of virtual work. Local maximum entropy shape functions are used which possess a weak Kronecker-δ property. This enables a direct imposition of Dirichlet boundary conditions if the boundary is convex. The limitations of this basis function are also addressed in this paper. Additionally, the search algorithm presented fulfills basic topological requirements. Several examples are investigated demonstrating the improved behavior of the stabilized OTM algorithm.

Keywords Meshfree methods · Reduced Integration · Hourglassing · Galerkin methods · Local maximum entropy approximation functions · Optimal transportation meshfree method

1 Introduction

Nowadays new and innovative products and processes are mostly developed in virtual labs. For a realistic prediction of the processes not only improved constitutive models, but also improved numerical solutions schemes are essential. For instance in the field of additive or subtractive manufacturing due

C. Weißenfels (✉)
Institute of Continuum Mechanics, Leibniz Universität Hannover, Appelstr. 11, 30167 Hannover, Germany
E-mail: weissenfels@ikm.uni-hannover.de

P.Wriggers
Institute of Continuum Mechanics, Leibniz Universität Hannover, Appelstr. 11, 30167 Hannover, Germany
E-mail: wriggers@ikm.uni-hannover.de