Mortar finite element methods provide a very convenient and powerful discretization framework for geometrically nonlinear applications in computational contact mechanics, because they allow for a variationally consistent treatment of contact conditions (mesh tying, non-penetration, frictionless or frictional sliding) despite the fact that the underlying contact surface meshes are non-matching and possibly also geometrically non-conforming. However, one of the major issues with regard to mortar methods is the design of adequate numerical integration schemes for the resulting interface coupling terms, i.e. curve integrals for 2D contact problems and surface integrals for 3D contact problems. The way how mortar integration is performed crucially influences the accuracy of the overall numerical procedure as well as the computational efficiency of contact evaluation. Basically, two different types of mortar integration schemes, which will be termed as segment-based integration and element-based integration here, can be found predominantly in the literature. While the entire existing literature focuses on either of the two mentioned mortar
integration schemes without questioning this choice, the intention of this paper is to provide a comprehensive and unbiased comparison. The theoretical aspects covered here include the choice of integration rule, the treatment of boundaries of the contact zone, higher-order interpolation and frictional sliding. Moreover, a new hybrid scheme is proposed, which beneficially combines the advantages of segment-based and element-based mortar integration. Several numerical examples are presented for a detailed and critical evaluation of the overall performance of the different schemes within well-known benchmark problems of computational contact mechanics.

Stichworte: Contact, mortar finite element methods, numerical integration, finite deformations

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