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damping; 2.7 Alternative Implementation of the Potential Contact Force; 3 Contact Detection; 3.1 Introduction; 3.2 Direct Checking Contact Detection Algorithm; 3.2.1 Circular bounding box; 3.2.2 Square bounding object; 3.2.3 Complex bounding box 3.3 Formulation of Contact Detection Problem for Bodies of Similar Size in 2D 3.4 Binary Tree Based Contact Detection Algorithm for Discrete Elements of Similar Size; 3.5 Direct Mapping Algorithm for Discrete Elements of Similar Size; 3.6 Screening Contact Detection Algorithm for Discrete Elements of Similar Size; 3.7 Sorting Contact Detection Algorithm for Discrete Elements of a Similar Size; 3.8 Munjiza-NBS Contact Detection Algorithm in 2D; 3.8.1 Space decomposition; 3.8.2 Mapping of discrete elements onto cells; 3.8.3 Mapping of discrete elements onto rows and columns of cells 3.8.4 Representation of mapping 3.9 Selection of Contact Detection Algorithm; 3.10 Generalisation of Contact Detection Algorithms to 3D Space; 3.10.1 Direct checking contact detection algorithm; 3.10.2 Binary tree search; 3.10.3 Screening contact detection algorithm; 3.10.4 Direct mapping contact detection algorithm; 3.11 Generalisation of Munjiza-NBS Contact Detection Algorithm to Multidimensional Space; 3.12 Shape and Size Generalisation-Williams C-GRID Algorithm; 4 Deformability of Discrete Elements; 4.1 Deformation; 4.2 Deformation Gradient; 4.2.1 Frames of reference 4.2.2 Transformation matrices 4.3 Homogeneous Deformation; 4.4 Strain; 4.5 Stress; 4.5.1 Cauchy stress tensor; 4.5.2 First Piola-Kirchhoff stress tensor; 4.5.3 Second Piola-Kirchhoff stress tensor; 4.6 Constitutive Law; 4.7 Constant Strain Triangle Finite Element; 4.8 Constant Strain Tetrahedron Finite Element; 4.9 Numerical Demonstration of Finite Rotation Elasticity in the Combined Finite-Discrete Element Method; 5 Temporal Discretisation; 5.1 The Central Difference Time Integration Scheme; 5.1.1 Stability of the central difference time integration scheme 5.2 Dynamics of Irregular Discrete Elements Subject to Finite Rotations in 3D

## Sommario/riassunto

The combined finite discrete element method is a relatively new computational tool aimed at problems involving static and / or dynamic behaviour of systems involving a large number of solid deformable bodies. Such problems include fragmentation using explosives (e.g rock blasting), impacts, demolition (collapsing buildings), blast loads, digging and loading processes, and powder technology. The combined finite-discrete element method - a natural extension of both discrete and finite element methods - allows researchers to model problems involving the deformability of either one solid body,