Congress on Numerical Methods in Engineering 2013
Bilbao, 25-28 June, 2013

Application of a Mixed Displacement-Pressure Finite Element Formulation Based on the Absolute Nodal Coordinate Framework to Biomechanical Problems

Elias Altarriba*[,1], Josep M. Font-Llagunes[2] and Aki M. Mikkola[1]

[1] Lappeenranta University of Technology (LUT)
Department of Mechanical Engineering
Skinnarilankatu 34, 53850 Lappeenranta, Finland
e-mail: elias.altarriba@lut.fi, web page: http://www.lut.fi

[2] Technical University of Catalonia (UPC)
Department of Mechanical Engineering
Avinguda Diagonal 647, 08028, Barcelona, Spain
Email: josep.m.font@upc.edu - Web page: http://www.upc.edu

ABSTRACT

The absolute nodal coordinate formulation is a numerical approach for solving problems which include large rotations and deformations [1]. In this approach, nodes are described using absolute position and slope coordinates. In the formulation, the mass matrix is constant and, in contrast, the stiffness matrix is nonlinear. In addition, the introduction of external forces and moments is more complex than in standard formulations. A large number of finite elements have been implemented using the absolute nodal coordinate formulation (for example beams, plates, cables, shells and solids).

The absolute nodal coordinate formulation is expected to be an efficient tool for simulating biomechanical systems. The biomaterials often contain a number of interdependent variables and mixed formulations are useful to express the relationship between those variables [2]. In addition, material incompressibility is also a typical phenomenon and this kind of problems cannot be solved using finite elements based on the standard one variable formulation [2]. In this paper, the displacement-pressure mixed finite element method based on the absolute nodal coordinate framework is introduced. Using this approach, the incompressible materials can be simulated using the absolute nodal coordinate formulation. This research is based on previous works for mixed finite elements on the absolute nodal coordinate formulation [3,4], and expands their applicability to biomechanical problems.

REFERENCES

[1] A.A.Shabana, "Computer Implementation of the Absolute Nodal Coordinate Formulation for Flexible Multibody Dynamics", *Journal of Nonlinear Dynamics*, **16**, 293-306, (1998).

[2] O.C. Zienkiewicz and R.L. Taylor, *The Finite Element Method*, McGraw Hill, Vol. I., (2000) Vol. II, (2000).

[3] E.Altarriba, O.N. Dmitrochenko and A.M.Mikkola, "Mixed Finite Element Formulation Using the Absolute Nodal Coordinate Formulation", 6th *Asian Conference on Multibody Dynamics*, Shanghai, China, (2012).

[4] E. Altarriba, J.M.Font-Llagunes and A.M.Mikkola, "Mixed Displacement-Pressure Formulation Using the Absolute Nodal Coordinate Formulation", *Serial Collection of Lappeenranta University of Technology*, Nro 87, Lappeenranta, Finland, (2012).