NUMERICALLY GENERATED TANGENT MATRICES FOR INTEGRATING NONLINEAR ANALYSIS CAPABILITIES OF DIFFERING FORMULATIONS AND IMPLEMENTATIONS

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Recently, difficulties in integration of software modules for nonlinear mechanics problems have motivated the authors to unify various procedures for generating tangent matrices that are dependent on formulations employed and element attributes as well as constitutive laws adopted, and deeply embedded into element generation routines. One possible unified approach is to generate tangent matrices numerically from the first variations of the strain energy functional, thus obviating formulation and element-specific intricacies. In doing so, it has been found that a key feature for consistency and robustness is to objectively treat the loss of rotational rigid-body modes due to geometric nonlinearities [1]. The present work builds on this key idea demonstrated through simple structures, and develops a general procedure applicable to three-dimensional nonlinear problems. The general procedure is then applied to infuse Newton-like solution capabilities into vectorially based legacy codes that do not have tangent generation features [2-3].

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References

[1] Lee, Y. J. and K. C. Park, "Numerically Generated Tangent Stiffness Matrices for Nonlinear Structural Analysis," *Computer Methods in Applied Mechanics and Engineering*, 191(51-52), 2002, 5833-5846.
[2] Stone, C. M. "SANTOS – A Two-Dimensional Finite Element Program for the Quasistatic, Large Deformation, Inelastic Response of Solids, *SAND90-0543*. Albuquerque, NM, Sandia National Laboratories, 1996.
[3] Mitchell, J. A., A. S. Gullerud, W. M. Scherzinger, J. R. Koteras, and V. L. Porter, "ADAGIO: Non-Linear Quasi-Static Structural Response Using the SIERRA Framework" In *First MIT Conference on Computational Fluid and Solid Mechanics*, edited by K. J. Bathe, p. 361-364, Elsevier, Amsterdam, 2001.