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Approach to Enhance Computational Robustness of Frictional Contact Analysis

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ABSTRACT

Frictional contact analysis is often considered among the most challenging problems of computational mechanics. In addition to complexity of geometrically non-linear contact models, frictional analysis can be associated with potential non-uniqueness of generated solutions [1]. It can be resulted, therefore, in difficulties to achieve converged results and, moreover, in uncertainty if the generated solutions are the right ones, even in case of successful convergence. These challenges can be especially important in case of high friction, i.e., for problems where friction-based responses (e.g., traction, wear, abrasion) are of prime interest and cannot be either ignored or simplified. The objective of this study, therefore, is to a) propose solutions to improve robustness of frictional contact analysis based on understanding of existing limitations; and b) demonstrate fidelity and efficiency of these solutions on representative examples, covering a broad range of considered variables including extremely high friction.

Proposed solutions are based on understanding of the coupling nature of interactions between contact normal and shear frictional stresses. Corresponding computational approach to control speed and robustness of the iterative process is proposed for analysis of the contact stress state. Relatively simple numerical implementation of the approach is demonstrated as well. Considered examples are selected to demonstrate applicability of the approach for the most severe scenarios of friction. It is shown that robust convergence is successfully achieved for all considered cases. Accuracy of generated computational predictions is demonstrated by comparison with available closed-form solutions. Systematic parametric studies are also performed to understand effects of other modelling parameters, e.g., number of elements. Generalization of the approach is further considered for more complex definitions of friction including potential sensitivity [2] to contact pressure and velocity. It is shown that the proposed solutions are perfectly applicable to such non-linear problems. Potential integration with general purpose FEA codes is discussed; and opportunities of integration with other advanced solutions [3] are outlined. Finally, the lessons learned and recommendations for practical computational implementation are summarized in form of conclusions.

REFERENCES

[1] M.R. Gurvich, “On challenges in structural analysis of rubber components: Frictional contact”, *J. Elastomers & Plastics*, **39**, 53-67 (2007).

[2] M. Scherbakov and M.R. Gurvich, “An approach of frictional characterization for elastomers and elastomeric composites”, *J. Elastomers & Plastics*, **35**, 335-356 (2003).

[3] M.R. Gurvich and M.S. Thompson, “An efficient computational approach for frictional analysis in ABAQUS”, *ABAQUS Users' Conference, Boston, MA, May 25-27, 2004*, 291-302 (2004).