A MODEL FOR SMALL-SCALE SURFACE FEATURES WITH APPLICATION TO FINITE ELEMENT ANALYSIS OF CONCRETE ARCH DAMS

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Both for reasons of economy and model simplification, it may be desirable to model small-scale surface kinematics indirectly, as a feature incorporated into the contact surface model. One interesting example of this is the modeling of contraction joints in concrete structures such as arch dams. Specifically, in a concrete arch dam the contraction joints run vertically, separating adjacent vertical dam elements. The contraction joints incorporate shear keys to both permit relative vertical and restrict relative lateral motion between the joint elements. The shear keys may be designed with rectangular or beveled cross sections. A finite element formulation has been proposed and implemented by Lau, et. al.[1] for the case of rectangular cross-section keys. For keys of rectangular cross-section, the kinematics are much simplified because lateral motion is prohibited even when the joint is partially open. In the case of beveled cross-sections, the joint may move a restricted amount laterally as a function of the joint separation.

This talk presents the formulation of a contraction joint model for the analysis of beveled contraction joints. The model allows for shear sliding behavior and incorporates the effects of restricted lateral motion and friction. The model is based on standard two-pass node-on-surface finite element technology, and hence can be incorporated within a large variety of existing finite element codes. In addition, the methodology does not require the meshes on each side of the contraction joint to coincide in the reference configuration, providing greater flexibility in the construction of the finite element model. The model was implemented within the general-purpose finite element programs NIKE3D[2] (for implicit calculations), and and DYNA3D[3] (for explicit calculations). A number of example problems are presented.

References

[1] D. T. Lau, B. Noruziann, and A. G. Razaqpur, "Modelling of Contraction Joint and Shear Sliding Effects on Earthquake Response of Arch Dams",*Earthquake Engineering and Structural Dynamics* , v. 27, p. 1013-1029, 1998.
[2] M. A. Puso, T. Laursen, and J. Weiss, "Contact Improvements in NIKE3D", UCRL-JC Report 125876, Lawrence Livermore National Laboratory, 1996.
[3] E. Zywicz and M. A. Puso, "A General Conjugate-Gradient-Based Predictor-Corrector Solver for Explicit Finite Element Contact", UCRL-JC Report 128410-Rev-1, Lawrence Livermore National Laboratory, 1998.