

# An improved algorithm of loading/unloading judgment for unconventional plasticity model applicable to non-proportional cyclic loadings

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## ABSTRACT

This paper presents an improved loading criterion in the elastic predictor/plastic corrector (return-mapping) algorithm for the extended subloading surface model for cyclic plasticity. Stress increments pointing inward of the subloading surface do not always lead to purely elastic unloading. More specifically, when a large stress increment in such direction is imposed, the subloading surface model can exhibit elastic unloading, followed by plastic reverse loading. During this transitional process, the subloading surface shrinks, and in some cases, degenerates to a stress point, and then expands toward the normal-yield surface. However, the standard loading criterion merely based on the elastic trial state may give an incorrect loading/unloading judgment, leading to serious error in numerical stress calculation. We thus develop a novel algorithm for the subloading surface model equipped with an improved loading criterion, together with a sub-step scheme, which can properly judge and track a process involving elastic unloading and plastic loading within an incremental step even in the above-mentioned cases. Numerical examples demonstrate that the proposed algorithm enables highly accurate stress calculation even in cyclic loadings with arbitrarily large strain increments.

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