Elastoplastic Analysis of Mises Metal by Return-mapping Algorithm for Extended Subloading Surface Model

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ABSTRACT

The extended subloading surface model [1] excluding a purely-elastic domain is capable of smooth transition elastic to plastic state. The elastoplastic cyclic loading behavior in addition to the monotonic loading behavior is expressed accurately by the extended subloading surface model.

High efficiently and accuracy calculation method is required for elastoplastic deformation analysis in FEM. The implicit stress integration algorithm with the return-mapping and the consistent tangent modulus tensor for the FEM analysis is known generally. The extended subloading surface model has been applied to the implicit stress integration method [2].

The elastic and plastic loading processes are judged by loading criterion in the return-mapping algorithm. However, the past loading criterion premise that the subloading surface expands in the plastic loading process and contracts in the elastic loading process. Therefore, it is applicable only to the description of monotonic loading process, but it is inapplicable to the description of the cyclic loading process which is possible to calculate erroneous result.

The rigorous loading criterion and initial value calculate method for normal-yield ratio in plastic corrector process [3] are adopted in this article. The proposed algorithm is possible to express expansion and contraction of the subloading surface even with wide range of strain increment. Therefore, it is applicable to the general loading process including not only forward but also inverse loadings. In addition, they are implemented into ABAQUS, which is general-purpose FEM software, through the user-subroutine called UMAT.

The implicit calculations for Mises metal by proposed and past the return-mapping algorithm are performed in the monotonic and the reverse loadings under the bi-axial loading state. The more accurate elastoplastic deformation analyses are represented by the proposed algorithm with the rigorous loading criterion and calculation algorithm of initial value calculate method for normal-yield ratio compared with the past algorithm. Thus, it may be stated that the accurate numerical solution can be attained by adopting the proposed return-mapping algorithm for the general loading process in the multi-axial stress and/or strain state.

REFERENCES

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