A Convergence Criterion for History-dependent Variational Inequalities

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Abstract: We consider a variational inequality in a reflexive Banach space X, governed by a history-dependent operator. The existence of a unique solution to the inequality is proved by using a fixed point argument. Based on the fixed point structure of the problem, we provide necessary and sufficient conditions which guarantee the uniform convergence of a sequence of functions to the solution. We exploit this result both in the study of a penalty method and the well-posedness analysis of the problem. Moreover, we present its application in the study of a mathematical model which describes the equilibrium of an elastic body in contact with a rigid-plastic foundation. The contact is frictionless and the hardening of the foundation is taken into account. We use our abstract results to obtain the continuous dependence of the solution with respect to various data and parameters. Finally, we use a finite element scheme to approximate the problem, implement it on the computer and provide numerical simulations which validate the theoretical convergence results.