THE CRITICAL EXCITATION OF INELASTIC STRUCTURES

by

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SYNOPSIS

A critical excitation of a structure drives one of its variables to a higher response peak than any other among some class of allowed excitations. This paper reports on the generalization of earlier results from elastic to inelastic structures.

PROBLEM AND SOLUTION

A question of importance in earthquake engineering which is rarely answered is this. Suppose that a structure is to be certified as resistant to earthquakes of some given intensity; what particular ground motions should it be able to withstand? In most current work, this question would probably be answered by saying that it should be able to withstand certain already recorded ground motions, or else certain artificially ones that are randomly generated. A third possible answer is an excitation which has been called "critical". It is an artificial ground motion also, but one which drives the structure to a higher response peak than any other of some designated class of allowed ground motions.

As has been shown previously, critical excitations are rather easily calculated if all ground motions up to a certain intensity are allowed, and if the structure is treated as elastic. If the intensity is measured by the square-integral of the ground acceleration, the critical excitation is more particularly found to differ by only a constant factor from the time-reversed impulse response of the structural variable of interest.

This result has recently been generalized to inelastic structures. It was found that the critical excitation is again a time-reversed impulse response. However, it is not the one of the structural variable itself but of one defined by a linearized set of equations. The linearization is more specifically the one that applies in the neighborhood of the critical excitation and response pair.

In order to determine such a pair, two sets of equations must be solved simultaneously: the nonlinear equations defining the inelastic structure and the linear ones defining the critical pair. It develops that, because of the time reversal, the solution can only be carried out by successive approximation. Moreover, the solution need not be unique: there may be more than one excitation/response pair that satisfies the equations.

Limited experience with numerical work indicates that the approximation process converges quite quickly.

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