EARTHQUAKE ANALYSIS VIA GENERALIZED NETWORK METHODS. PRINCIPLES, POSSIBILITIES AND PRACTICE.

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SYNOPSIS

Otherwhere (1), it has been shown how the methods of network analysis, as compactly described, by ex., in (2), may be powerfully used: 1, to clear very general concepts; 2, to solve more easily and effectively very typical problems and, 3, to allow for a more rational approach to the specification and testing, in a number of cases within the earthquake engineering. Here, the writer hints on the promising possibilities which are open, when these methods are generalized by means of the concepts of modern functional analysis.

DISCUSSION

On a network, each time a signal or excitation S is applied to one port, a definite output or response R will be obtained at another, the network acting as an operator transforming excitation into response. This operator can be mathematically modeled by a commutative and associative "convolution transform" R=S*T, as defined in classical analysis, if, and only if, the system is linear, continuous and time invariant, i.e., "iff it is a filter", see (3) and (4).

The transform function T can be accounted for, by replacing the signal S through a Dirac sequence δ: it can be shown, (3), that $\delta * T = T$, that means, Dirac sequences act as a unit for convolution and T may be taken as the "impulse response" of the system. Moreover, it can be shown, (3), that, on derivation, $\delta' * T = T'$; and further, that the Fourier transform of R, is the common product of the transforms of S and T. These, are the principal grounds for the applications, (1).

In functional analysis, convolution is defined on very general (Banach) spaces, between infinitely derivable measures (distributions). The operator is, therefrom, generalized, so much as to allow for the modeling, not only of networks with lumped elements, but also, those including transmission lines with dissipation (5).

Pairs of "immitance variables", either forces or displacements, such as used in former networks to describe both the functions R and S, will yet often not suffice, as they could be, possibly, not physically measurable. Instead, pairs of "scattering variables", describing the reflection coefficients of the transmission lines involved, in an "energy like way", will be able to characterise their inherent propagation, reflection and dispersion of waves. The latter variables will serve, further, as an alternative to immitance variables, symplifying often the mathematics of the system.

On considering that some of the most developed methods being presently employed in the seismic analysis, as for ex., the finite element method of determining the interaction structure-ground, (6), do not represent more than the use of an analog lumped network to numerically reach the modes of a sectional model, in the geometrical shape of the original, but only too roughly representing its boundary conditions and disregarding, by the way, any propagation time of signals, one appreciates clearly the advantages of an eventual generalized network method of attack.

The method we envisage, would involve by ex., the modeling of structure and ground by networks, the scattering or immitance variables of whose elements would be either determined from frequency methods, or directly measured by excitation through vibration generators or impulse geoseismical sources.

It should be underlined, further, that network theory has developed its methods, including, indeed, those on a "signal-response" basis, much further than to cope only with the linear, continuous, time invariant case. The transform method of approach to time-variable-parameter systems, the "quasilinear" methods for second order non linear systems, and the "describing-function" frequency response approach to the same, are good examples on this assertion (7).

As a conclusion, it could be said that the earthquake engineering is in need of attracting generalized network theorists into its field, to further advance its methods.

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