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Forecasts of dynamic response for structural systems with low robustness (Article)

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Abstract

In the paper one addresses the problem of forecasting the dynamic response of structures behaving according to rocking modes. Purely rotational motions do often occur in structures and facilities subject to seismic solicitations, turning those in monolithic rigid bodies or assemblies. Rocking dynamics, thus, usually interests a wide variety of structures and objects, also including historical and monumental constructions or ancient art items, usually made of largedimension monolithic stone blocks. Nevertheless, the high nonlinearity and complexity affecting the rocking dynamics of rigid bodies make hard to perform some reliable forecasts about their response, and push towards the adoption of alternative strategies. © 2015, North Atlantic University Union. All right reserved.

Author keywords

Dynamics; Earthquakes; Modeling; Monolithic bodies; Response forecast; Structures

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Forecasts of dynamic response for structural systems with low robustness

I. Corbi, N. Mastorakis

Abstract— In the paper one addresses the problem of forecasting the dynamic response of structures behaving according to rocking modes. Purely rotational motions do often occur in structures and facilities subject to seismic solicitations, turning those in monolithic rigid bodies or assemblies. Rocking dynamics, thus, usually interests a wide variety of structures and objects, also including historical and monumental constructions or ancient art items, usually made of large-dimension monolithic stone blocks. Nevertheless, the high nonlinearity and complexity affecting the rocking dynamics of rigid bodies make hard to perform some reliable forecasts about their response, and push towards the adoption of alternative strategies.

Keywords—Modeling, Structures, Dynamics, Response forecast, Monolithic bodies, Earthquakes.

I. Introduction

In mathematical models of structural phenomena a number of approximations or simplified hypotheses are usually necessary and admitted, either because of difficulties in reproducing the complexity of the real conditions and because of the need of making the models manageable for practical purposes and further investigations.

This results in some uncertainty embedded in the model itself, which superposes to the uncertainty affecting the real modeled phenomena, which turns into some uncertainty in both the input and output data.

In the following, with reference to structures behaving according to a rigid mode under seismic-type dynamic excitation, one discusses the desirability of adopting worst scenario approaches for producing reliable forecasts about the response of such structures.

II. Real Processes and Worst-Case Analyses

The prediction of real processes thus appear deeply influenced by uncertainty, which should be handled or treated somehow in order to guarantee some degree of reliability of the relevant forecasts.

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The availability and amount of input data plays a central role in the choice of the approach to be adopted.

In case when one does not have at one's disposal the probability characterization of input data, stochastic methods should be discarded, rather preferring some worst scenario or fuzzy approaches.

In engineering applications where one has to check that some output variables of the problem do not exceed some given thresholds at selected locations, worst scenario approaches are aimed at searching for the input data that maximize those variables.

The state problems can stand for differential or integral equations, or a system of linear equations, thus allowing the treatment of a wide variety of problems [1]-[4] relevant to new, existing or ancient structures [5]-[20], where main sources of uncertainties are encountered.

Fig.1: Electrical transformer failure during the 1971 San Fernando earthquake, and remains of the

Usually the problem may be, then, set up by selecting a suitable criterion functional, with the objective of identifying the values of the sets of parameters it depends on that make it maximum.

Seismic analysis and design of buildings finds a powerful tool in worst scenario approaches, since the common objective of reliably forecasting the structural response of constructions or designing earthquake-resistant structures consists of ensuring their structural safety in the worst situation, that is to say against the worst possible future earthquakes.

This also in the light of future dynamic load, that may be hard to be forecasted in their properties [21]-[22].

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