Chapter XVI

Neural Networks for the Simulation and Identification Analysis of Buildings Subjected to Paraseismic Excitations

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Abstract

The chapter deals with an application of neural networks to the analysis of vibrations of medium-height prefabricated buildings with load-bearing walls subjected to paraseismic excitations. Neural network technique was used for identification of dynamic properties of actual buildings, simulation of building responses to paraseismic excitations as well as for the analysis of response spectra. Mining tremors in strip mines and in the most seismically active mining regions in Poland with underground exploitation were the sources of these vibrations. On the basis of the experimental data obtained from the measurements of kinematic excitations and dynamic building responses of actual structures the training and testing patterns were formulated. It was stated that the application of neural networks...
enables us to predict the results with accuracy quite satisfactory for engineering practice. The results presented in this chapter lead to a conclusion that the neural technique gives new prospects of efficient analysis of structural dynamics problems related to paraseismic excitations.

Introduction

Structural vibrations induced by ground motion can be caused not only by earthquakes but also by human activity. Some of the sources of paraseismic excitations, as for instance traffic vibrations and industrial explosions, may be inspected and controlled. On the other hand, mining tremors resulting from underground raw mineral material exploitation are random events. Although these tremors are strictly connected with the activity of man, they differ considerably from other paraseismic vibrations. Neither the moment and place of their occurrence nor the magnitude can be foreseen, like in the case of earthquakes.

The estimation of building dynamic properties (first of all the periods of natural vibrations) and dynamic response of building subjected to kinematical excitations are very important problems of structural dynamics. The basic approach is related to full-scale measurements on actual buildings (Ciesielski, Kuźniar, Maciąg, & Tatara, 1992). In many cases such an experimentally supported analysis can be superior to the computational analysis. There are, obviously, many problems related to organization and costs of the tests on real buildings in the natural scale.

On the other hand, a structural dynamic analysis involves many tasks (e.g., formulation of a real model of building). Besides, the problem is related to very complex structures such as buildings, in particular—prefabricated buildings. There are a lot of difficulties with material, structural and load modelling. In spite of extensive development of computational methods (first of all the finite element method) and progress in computer software and hardware, the analysis of building vibration problems is far from satisfactory from the structural engineering point of view. That is why there are attempts to explore nonstandard, codisciplinary approaches in the analysis of the mentioned problems. From this point of view artificial neural networks (ANNs) seem to be a new tool, very prospective for solving the problems.

The chapter deals with dynamic analysis of medium height prefabricated buildings with load bearing walls subjected to paraseismic excitations. Mining tremors in strip mines and in the most seismically active mining regions in Poland with underground exploitation—Upper Silesian Coalfield (USC) and Legnica-Glogow Copperfield (LGC)—were the sources of these vibrations. The results of long-term experimental monitoring of actual structures were synthetically collected. The created database of the experimental data obtained from the measurements of kinematic excitations and response building vibrations makes it possible to use them to design the neural analysers for complete considerations of the building dynamic problems. The main problems discussed in the chapter deal with the application of neural networks to identification of dynamic properties of actual buildings, simulation of building responses to the paraseismic excitations, mapping of seismic parameters into response spectra on the ground level and simulation of response spectra on building base-ment from input spectra on the ground level.
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