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THE FUNDAMENTALS OF FUNCTION AND DEVELOPMENT OF THE ENGINEERING-SEISMOMETRIC NETWORK

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ABSTRACT

On ESN's stations the information about motion of construction's elements and adjoining ground is recorded. This information is used in research into the Earthquake-engineering by identification methods and in research into a models of seismic effects. It is used into practice for improvement of building's reliability by the methods of beforehand analysis of chainging of building's dynamic parameters in the precess of exploitation and for reduction of ecological hazard from technological processes on some factories subjected to a earthquake by the method of outomatic control of seismic situation with overtake blockading of technological process.

KEYWORDS

Earthquakes, constructions, observations, earthquake-engineering, reliability, safety.

INTRODUCTION

For effective, economical building in a earthquake-phone regiones a scientific data about earthquake excitation and real behaviour of construction under earthquake are required. With 1967 a isolated observations of construction's and adjoining ground's strong motion were consolidated into the Engineering-seismometric network (ESN), which received statute of the federal network in connection with foundation of the Russia's Federal System of Seismological Networks and Earthquake Prediction in 1993. ESN's duties are keeping Earthquake-Engineering in Russia supplied with engineering-seismometric information; valuing of building's real seismic-resistance and keepin Ministry for Emergencies of the Russian Federation supplied with forecast information about a probability of building's destruction and with information about a earthquake-effect.

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ESN is valuing of real seismic-resistance for available buildings. A fundamentals of this valing are the methods: full-scale investigation; forced vibration test; analysis of chaining of building's dynamic pa-rameters; reliability calculation; post-earthquake inspection. This information together with information about seismic hazard by the method of seismic risk make it possible to obtain the prediction of a earthquake-effect depending on earthquake's type. At last ESN obtaines promptly a information about condition of city's construction after earthquake by the method outomatic determining of building's condition.

At the present time earthquake engineering has three very different sources of experimental data. These are the model investigations, the full-scale investigations, and the engineering-seismometric observations. The model investigations are experimental researches, that are performed at structure models with different kinds of sources, modelling the seismic effects. These sources can be vibrating tables, platforms and so on.
The main disadvantage of such investigations is the fact that the obtained results can be applied to the real objects only with large approximations.

More reliable results are obtained in full-scale investigations,which are conducted usually on real structures or on large scale construction fragments with different sources modelling the seismic effects. In this case the most difficult problem is the problem of powerful seismic effect modeling, which are really dangerous for structures studied. At these tests mainly powerful vibratos and explosions are sources of excitation. However, they not provide yet necessary approximation of seismic actions, especially at low frequencies. It is especially important for high structures and for structures, which have some systems of active earthquake protection.

Engineering seismometric observations providing the receipt of information about real construction behavior at real earthquake. Therefore, it is these observations that give necessary reliability of information about performance of building structures. Note that for model and full-scale investigations the ESN information is needed too. The such tests can be truly organized only when this information is known. So one can create actually dangerous for structures earthquake effects and provide the necessary level of strains and deformations in construction elements for trials.

Thus the engineering seismometric information, obtained by ESN stations is one of basic experimental materials of earthquake engineering. It mainly define the development level of earthquake engineering. This information is the basis for theoretical elaborations of design methods improvement of structures on seismic effects and for the test of research results and practical design on earthquake resistance. This information is original materials to define more precisely the existing normative rules and estimate the earthquake intensity.

THE BASIC DIRECTIONS OF INFORMATION ANALYSIS

Improving a Dynamic Models of Structures

Traditionally modern ESN stations making registration of the vibrations of different elements of building structures and adjoining ground supply with information the wide class of earthquake engineering problems.

First of all engineering-seismometric information allows to make clear the reserves of carrying ability of constructions. Methods of constructions design on earthquake resistance because of our restricted knowledge about physical structure model are approximation. To provide the needful carrying ability of construction by means of modern structure design methods for given constructive solutions the levels of seismic loads, the degree of construction strengthening, volumes of building materials for providing of building earthquake resistance are determined. The engineering-seismometric observation's results are differed from design predictions. In dependance of difference between observed data and design prediction one can decide about necessity of construction strengthening or about possibility of reduction of aseismic actions to provide the needful carrying ability of constructions. In the first case the necessary level of construction reliability is provided, in second case the possibility of building materials economy

is discovered. Besides ESN data also allow in this case to improve design methods indicating the necessity of account of many factors defining the performance of the structures, i.e. the necessity of changing of structure dynamic modelor providing the receipt of empirical dependance for parameters whose values in design were taken hypothetically, remaining on positions of used dynamic model (Dorofeyev, 1979, Denisov *at al.*, 1982 a,b) .

Creation of New Constructive Building Solutions

The same importance ESN information has for improvement and creation of absolute new constructive building solutions. Really, if on the basis of above-mentioned investigations the reserves of the needful carried ability of constructions were exhausted and on the basis of engineering-seismometric information one founded some or the other constructive elements of structures which are working on the limit of their possibilities and are determining the carrying ability of structure in whole, then on the basis of obtained ESN information for this structure and on the basis of our theoretical models one can change these constructive elements or develop absolute new construction that will work in more easy force conditions by transmission the more load to other elements which early were loaded insufficiently that is seen from analysis of ESN information. So on the same materials expenditure by means of the constructions improvement, i.e. by redistribution of loads one can obtain more reliable construction that unfortunately is equivalent to the increasing of construction economy.

Increasing Exploitation reliability of Structures

For the most important buildings the engineering seismometric stations installed on them give us information allowing to increase exploitation reliability of these constructions. Systematically ESN information obtained for objects upon weak and middle earthquakes allow to trace the change of its dynamic parameters characterizing structural changings in the materials and in the constructions which lead to the reduction of earthquake resistance ability in a whole. When ESN data give us facts of the changing of dynamic parameters out of acceptable limits it's necessary to make more detailed experimental analysis of constructions to ascertain the reasons of decreasing of the structure carrying ability which can cause the accident situation under earthquake and to remove them. Such exploitation analysis of ESN information allows essentially to increase reliability of structure performance and ultimately lead to economy by timely removal of secondary negative effects which can arise as a result of construction damage upon earthquake, for example such as great people and material losses because of the construction is responsible.

Creation of Common and Regional Earthquake-Effect's Models

Due to fact that at the stations of engineering seismometric observations the movement registration of adjoining ground to construction is carried out then correcting the distortions of these registrations which are caused by building oscillations they can be used together with engineering seismometric informations for the studying general and regional features of seismic actions (Dorofeyev, 1988) and also as support points during making more precise microseismozonation maps of towns, where the ESN stations are situated. The mathematical models of general and regional seismic action constructed on basis of engineering seismometric data and ESN information are more effective in structure design on seismic effects, if on the basis ESN information it's possible to find empirical parameters of this realizations from these models which are more dangerous for one or another construction type. All this indicates the great role of ESN information in the development of design models of seismic actions.

Reduction of Ecological Hazard from Accident under Earthquakes

The engineering seismometric information is used also for automatic control of seismic hazard at objects where accident under earthquake lead to increased ecological hazard. Depending on function of enterprises and used technology at it on the basis of control signal which is produced by ESN station in

the case of critical situation the automatic operations for reduction of secondary consequences caused by accident are conducted at these factories subjected to earthquake. for example at chemical plants and at the ecological hazard biological enterprises the blockading of technological cycles to prevent the ecological hazard consequences can be made; at the chemical, military object and at oil-work enterprises, high voltage is turned off to prevent the explosions and ecologically dangerous fires, automatic action to prevent leakage of poisonous and fire dangerous substances can be also made at these factories; at the atomic stations and similar objects the removing of nuclear elements from active zone of reactor can be made.

Determination of Real Earthquake-Resistance of Existing Building of Towns

The main way to save people and the economy from destructive earthquakes is the earthquake engineering. Therefore successes in realization of actions in this field give most effect and on the contrary the most losses arise that from destruction of residential, public, industrial and other structures. In deal with development and improvement of seismological science the data about seismic hazard in different regions of country are changing, but the large part of towns, villages, buildings and structures was already built in these regions taking into account the former seismological data. This is complicated by circumstance that earthquake resistance of buildings and structures is changing with the time. According to this fact at present the main problem for the people's saving upon earthquake is the problem of determination of real seismic resistance of existing building of towns. Only having these data one do can reliability predict earthquake consequences and perform preventive actions for the reduction of the vulnerability of constructions and buildings in seismic regions of country. The collection of this information is actual, but nontraditional task of ESN. This problem can be effectively solved by creation in different towns of country of computer-aided system of destruction buildings hazard prediction under seismic actions of natural or artificial character.

Operative Data Acquisition about Earthquake Effects

The second duty of ESN is the problem of providing the Ministry for Emergency of the Russian Federation and state executive organizations supplied with forecast information about earthquake effects. This problem can be solved by the creating for each town of the country the computer-aided system of fast determination of building's conditions after strong earthquake. It is the engineering seismometric network that provides this primary information for operation of such system. The units of the network have to be placed at different objects representing the typical buildings and the most important structures of town. The units have to be able to measure either the natural period of oscillations as well as the decrement factor of building or their fluctuations from original values. When a unit receives a certain command from above-mentioned central town system it starts to obtain information. After that the unit transmits obtained results back to the central town system. The connection between units and central computer-aided system have to be made by means of radio waves.

CONCLUSIONS

A results of working ESN are: the engineering-seismometric information databank (for research into the earthquake-engineering); the building's real seismic-resistance databank (for solution of problems of construction's strengthening with the purpose to reduce seismic risk); the computer-aided system of engineering-seismometric information's interpretation (for improving of earthquake-effect's models and a dynamic models of constructions); the computer-aided system of destruction buildings hazard prediction under earthquake and vibration effect (for solution of problems of consruction's strengthening and of resources's preparation for effective restoring of city's constructions); the computer-aided system of fast determination of building's condition after earthquake (for solution of problems of people's saving and fast or systematic restoring of city's constructions.

Function and development of the Engineering-seismometric network ensure further earthquake-engineering progress and success in reliability calculation's methods. A ESN's working makes it possible

to reduce an ecological hazard from technological processes on some factories subjected to earthquake and to solve problems of reducing of seismic risk, people's saving and restoring of city's constructions.

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