SENSORS FOR THE NATIONAL NEURAL NETWORK FOR PROTECTION OF BUILDINGS AND FACILITIES FROM SEISMIC AND WIND LOADINGS

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Key words: *Signal Processing in L_2; Seismic wind and fire protection; Elevator devices; Computers and Sensors; Elevator Shafts; Contemporary Seismic Micro zoning; National Neural Networks.*

Abstract: *The sensors (3D accelerometers) of the described network forms a specific subsystem. This is a continuously functioning subsystem that performs constant monitoring of the dynamic behavior of buildings and facilities. The monitoring in modern earthquake engineering provides richer information in real time for all buildings and facilities in the aggregate of the data obtained from possible seismic micro zoning. The monitoring offered by using the sensor subsystem allows to immediately determine the dynamic characteristics of all buildings in the National Neural Network (several millions elevator devices). If the conditions of Theorem 8 of the study are met, this allows to guarantee the indestructibility of the neural network nodes even in the case of buildings with pre-defined defects.*

The First part of the research describes Automatic systems for active control oond direction is related f the structural dynamical response. This variant of the study represents a Neural Network consisting of a huge amount of automatically controlled systems. They are built over the existing elevator devices of seismically-vulnerable (from 3 to 16 floors) and wind-vulnerable (over 16 floors) buildings and facilities in seismic areas. Building infrastructure is controlled by the existing elevator shafts of the buildings. Contemporary subsystem of the proposed Neural Network (Seismic Micro zoning) over the dynamical sensors is created. This subsystem allows to organized continuous 24/7 monitoring of the dynamical response of Neural Network. The network is designed for existing buildings in their operational period. Moreover, if the conditions of proofed in the study theorems are met, this allows to guarantee the indestructibility of the neural network nodes (building structures) even in the case of buildings with pre-defined defects.

The Second part of the research represent Automatic systems with passive control. This variant of the development is an aluminum skeletal structure of a building on a neoprene insulation layer fixed on a common reinforced concrete slab of the building. All walls are of massive pneumatic construction, which consists of a thin rubberized structure filled with compressed air. This system provides fire protection.

СЕНЗОРИ ЗА НАЦИОНАЛНАТА НЕВРОНА МРЕЖА ЗА ЗАЩИТА НА СГРАДИ И СЪОРЪЖЕНИЯ СРЕЩУ СЕИЗМИЧНИ И ВЕТРОВИ НАТОВРВАНИЯ

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Ключови думи: *Обработка на сигнали в L_2; Сеизмична, ветрова и огнезащита; Елеваторни съоръжения, Компютри и сензори, Елеваторни шахти, съвременно сеизмично райониране, Сензори за Невронни Мрежи.*

Резюме. *В статията са преставени различните видове сензори, които могат да се използват в разработката* ***FREQUENCY L2 ANALYSIS OF THE NATIONAL NEURAL NETWORK FOR PROTECTION OF BUILDINGS AND FACILITIES FROM SEISMIC AND WIND LOADINGS.*** *В активната версия на изследването, сеизмично уязвими (от 3 до 16 етажа) и ветрови (над 16 етажа) сгради с функциониращи асансьори са обединени в невронна мрежа. Основните обекти – СЕНЗОРИ и ИНЕРИЦИАЛНИ ДВИГАТЕЛИ на активните системи за управление, са разположени в асансьорните шахти на сградата (поне четири копланарни двигателя в горната част на ВСЯКА асансьорна шахта на предложената невронна мрежа, съгласно Фигура 5). Съответно на предварително изготвен инженерен проект за асансьори за ВСЯКА СГРАДА, 3D акселерометри са поставени във основите на асансьорните шахти и в горната част на асансьорните шахти. Инерционните двигатели са поставени в горната част на асансьорната шахта и на допълнителни места върху покривната конструкция (ако е необходимо по изчисления). Акселерометрите и двигателите са елементи на невронната мрежа и за всяка асансьорна шахта те образуват ВЪЗЕЛ на мрежата (съгласно предварителните условия на Теорема 8 от изследването).*

Introduction

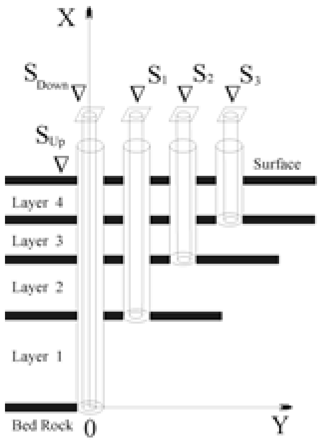
Seismic NPP-s micro-zoning and NPP Soil-Structure Interaction Sensors

Some people sense danger – this is inherited from animals. The dog, which descended from the wolf through domestication, has the most acute sense of danger in the living world. Ten days before the disaster in Fukushima, a large group of Bulgarian scientists felt threatened and tried to get help from the then Bulgarian government. On March 10, 2011, the scientific team wrote to the Bulgarian Prime Minister that the nuclear earthquake Armageddon was imminent. The next day, on March 11, 2011, the Japanese, being fakirs, managed to remove the nuclear fuel from the Fukushima plant. If a parallel nuclear power plant outside the earthquake zone had been turned on within 10 minutes (the time of the tsunami soliton wave in the earthquake zone) and the temperature drop had begun immediately, the terrible disaster at Fukushima could have been avoided.

On December 28, 2022, the 24 Hours press group (24 Hours – 168 stories) and our scientific team warned that a catastrophic earthquake was coming to the Balkans: https://www.24chasa.bg/articla/13797525. A week later, an earthquake occurred on the island of Crete with a magnitude of M=5.7. A month and a week later, on February 6, 2023, a pair of twin earthquakes will occur in the Kahramanmaraş region with a magnitude of M=7.7 and M=7.8. Such a phenomenon with a pair of twin epicenters occurs once every 500 years. Over 60,000 people died. Bulgaria was the first in the world to come to the rescue through a rescue operation by land, air and water. The rescue mission was led by the then Deputy Prime Minister and Minister of Interior Affairs Ivan Demerdzhiev.

Seismic NPP-s micro-zoning and NPP Soil-Structure Interaction Sensors

The free field signals are very important characteristics of any seismic site. Moreover, they are essential data for the development of the two most fundamental NPP tasks connected with the construction of NPP-s: I**. Seismic NPP-s micro-zoning.** This task consists in the determining of the probability NPP-site parameters, such as: geological data, seismic region intensity, magnitudes, return periods, seismic risk analysis, seismic hazard, layer velocities, attenuation law etc . Free field experimental and numerical signals represent the most informative seismic micro-zoning characteristics of the NPP- site. All other above-mentioned parameters can be obtained using the free field signals. **II. An NPP Soil-Structure Interaction**. This task consists in determining the NPP- structure response. Bedrock or coming from one of the “layers” signals can be used as input data. The response of an NPP- structure can be obtained following the well known soil-structure interaction modelling procedures. The above mentioned tasks I and II can be solved by **III. Experimental Polygons and Sensors.** The geometrical model of the investigated geological column is shown in the figure III Polygons. It represents the official geological profile of the building site of the NPP Belene-East (shallow profile). The table shown in this figure contains the following data: layer number, depth, volume density, SH transverse wave velocity. Seismic sensors are marked with S in the **III**. The sensor registering the variation of the ground particles’ velocity is marked with SUp. The sensor registering the variation of the bedrock particles’ velocity is marked with SDown. Besides, S1, S2, S3 represent the sensors registering the velocity variation of the ground particles’ situated at the boundaries of layers 1, 2 and 3 respectively. Sensors S_{Down}, S_1, S_2, S_3 are placed upon steel plates, welded to steel tubes, fixed in corresponding layers’ boundaries. The tubes are placed in drillings, besieged by PVC tubes. Detonations are carried out into the deep drilling using the device shown in fig.2. The sensors register all SH falling, passing and reflected waves at the corresponding layers, at bedrock and surface boundaries. The experimental work station is OYO McSEIS (Japan) type. The sensors are VEGIK (Russia) type. The sensitivity of the sensors is 0.290 [V/m.s], the natural frequency of the sensors – 11 Hz and the damping of the sensors is 28%. The constant part of the frequency response function of the sensors is from to the periods 0.03 [s] to 0.5 [s]. Amplification of the sensors is 40 000.



N	H	ρ	Vs
Layer	[m]	[t/m³]	[m/s]
4	4.5	1,9	300
3	3.5	1,8	270
2	6.0	2,2	420
1	10.0	2,0	530
5	∞	2,2	600

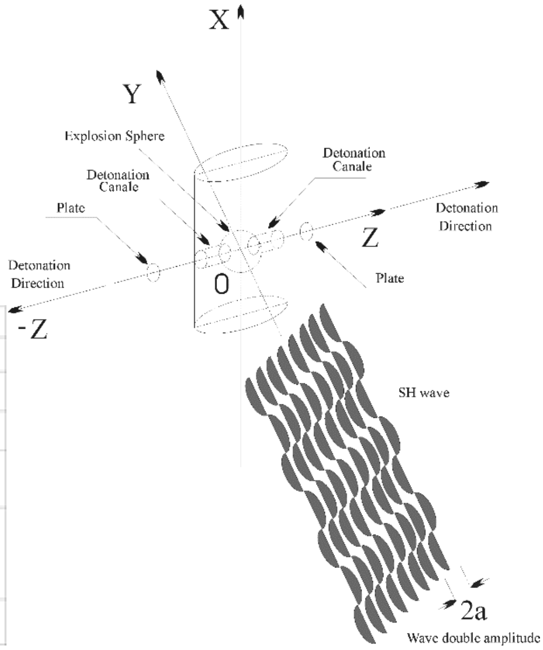


Fig. 1. Experimental polygon and Detonation device for SH wave generating

Sensors

The sensors described in the section III have very high characteristics. They are used when determining the signals of a NPP site free field signals. The sensors in the proposed article for National Neural Network are from a completely different type. They are lightweight and millions of them are installed in the elevators of buildings. Their characteristics are selected so that they can provide the conditions for applying Theorem 8 at any moment in time, as follows [1–13]:

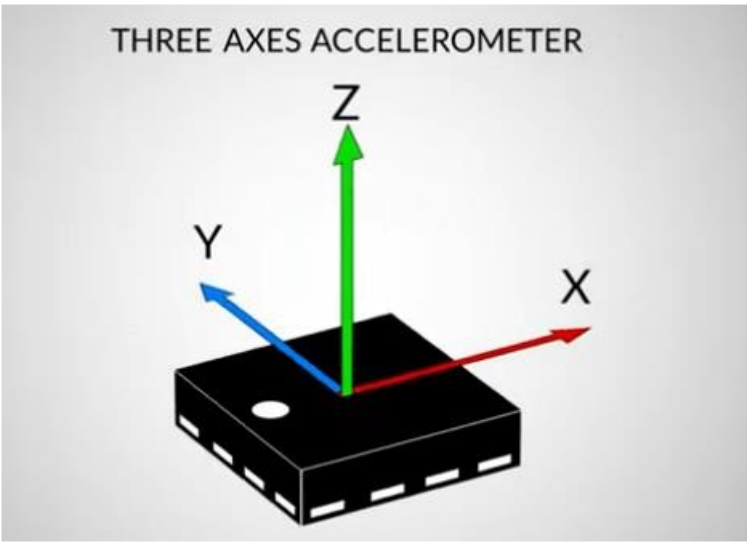


Fig. 2. Three Axes Accelerometer – Principle Scheme

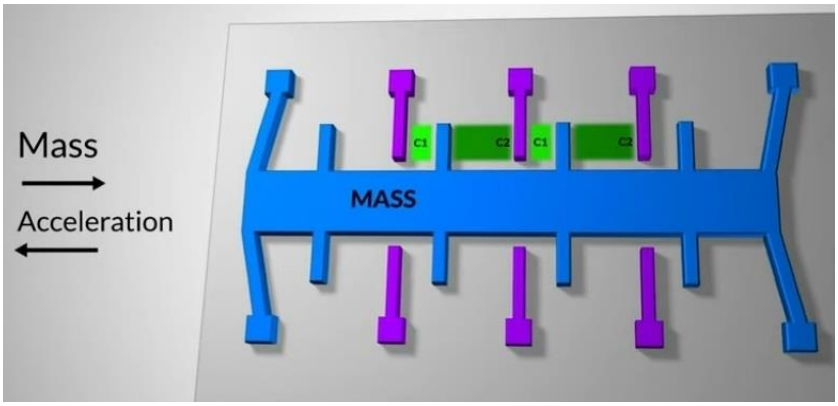


Fig. 3. MEMS Capacitive Accelerometer Type – Principle Scheme

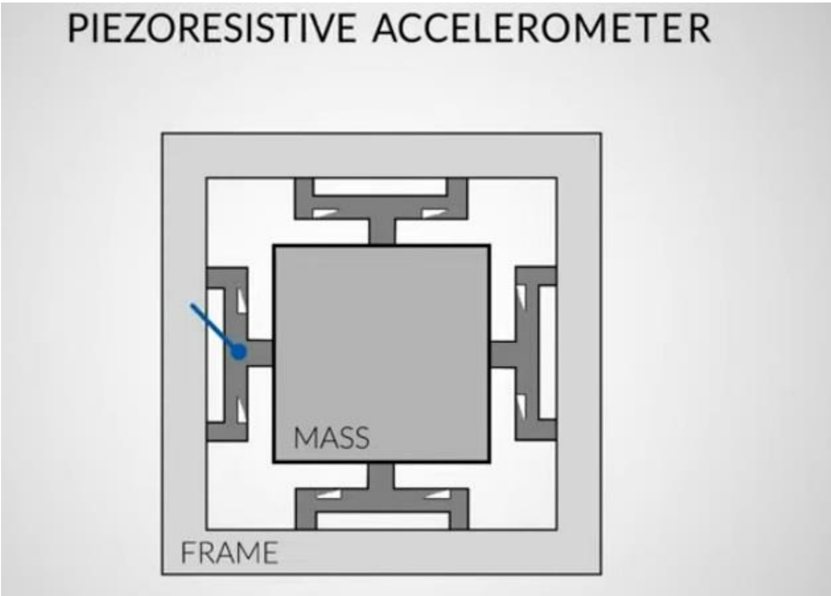


Fig. 4. Piezoresistive Accelerometers Type – Principle Scheme

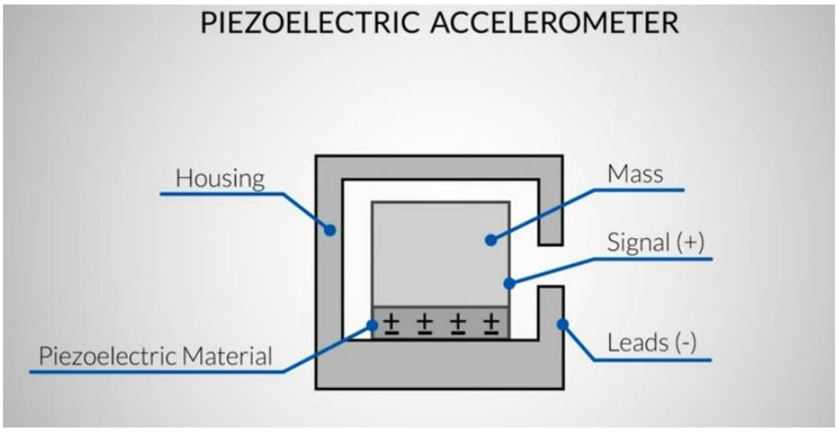


Fig. 5. Piezoelectric Accelerometer Type - Principle Scheme

There are various systems for reducing the effects of earthquake and wind on buildings and construction equipment (Кондов, В., Д.Банкова, (2023), Управление на сеизмичния риск част 1, Kondov, V., D.Bankova, (Control of the Seismic Risk part 1), Международна конференция дни на науката, Варна, 2023, Механика на машините, 131, книга 1, ISSN 0861-9727, стр.124–128, (in Bulgarian), (Kondov, V., D.Bankova, (2023), Seismic risk management part 1, Kondov, V., D.Bankova, (2023), (Control of the Seismic Risk part 2), Международна конференция дни на науката, Варна, 2023, Механика на машините, 131, книга 1, ISSN 0861-9727, стр.129–133, (in Bulgarian). In the practice in case of some of the systems a sufficient amount is used in practices high-strength materials – concrete and steel reinforcement. In other cases, variable structure systems are used to avoid resonance phenomena. Systems with automatic control of the dynamic response of the infrastructure are used in the study. The essential elements of the proposed sensors for Neural Network **Figure 2, Figure 3, Figure 4, Figure 5 [1, 2, 3, 4, 5]. Essential result are presented in the** Theorems 6 and 8. Theorem 6 represents a continuous analogue of the discrete fast transform of Cooley and Tuckey FFT **[4]. Theorem 8.** [Indestructibility of the neural network's branches, *FREQUENCY L2 ANALYSIS OF THE NATIONAL NEURAL NETWORK FOR PROTECTION OF BUILDINGS AND FACILITIES FROM SEISMIC AND WIND LOADINGS.*] The necessary and sufficient conditions for the indestructibility of the neural network's branches are: **A** (The Kinetic energy of the Network) The velocities of each of the network nodes during dynamic impacts **TENDS** to **ZERO,** and **B** (The Total Potential Energy of Deformations of the Network) The total potential energy of deformations of all nodes of the Network during dynamic impacts **TENDS** to a **MINIMUM**.

Conclusions

Theorems 1–8 forms the frequency conditions for creating of frequency analysis in space l_2 of national neural network for protection of buildings and facilities from seismic and wind loadings. In this report the sensors foe National Neural Network are presented.

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