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NATIONAL NEURAL NETWORK FOR SEISMIC, WIND AND FIRE PROTECTION OF BUILDINGS AND FACILITIES THROUGH RENOVATION OF EXISTING ELEVATOR DEVICES

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Abstract: *Dynamic vulnerability type buildings are protected by neural network over the elevator renovation. Such a neural network guarantees full protection of people and animals in existing buildings with elevator devices during a hurricane wind or an earthquake of arbitrary magnitude, arbitrary duration and spectral composition of seismic signals.*

Keywords: *Signal Processing, Seismic, wind and fire protection, Elevator devices, National Networks.*

INTRODUCTION

Seismic and wind infrastructure vulnerability. About 95 % of the Earth's population lives in high-rise apartment buildings. According to Signal Processing theory (Poularikas, A. D. 2000) three type of buildings are described in the report

Buildings up to 3 stories are high frequency and rigid. They are slightly affected by seismic signals, which are of low frequency. In case of an earthquake, the evacuation takes seconds.

Buildings between 3 and 16 floors are strongly affected by seismic signals, because in this frequency range they enter into resonance with the spectral characteristics of seismic signals.

Buildings over 16 stories are low-frequency and hardly resonate with seismic signals. These buildings are strongly affected by hurricane winds, because these are the spectral characteristics of hurricanes.

Another very important dynamic characteristic of dynamic inputs is the duration of signals. According to the mechanics of destruction, short-term dynamic signals of less than 20 seconds, for example, can hardly enter into resonance and lead to serious disturbances of massive buildings.

Buildings between 3 and 16 floors are considered seismically vulnerable. Almost all such buildings are equipped with elevators. This enables them to be combined into a neural network. Existing elevator devices represent no less than 70 percent of the cost of such a national neural network.

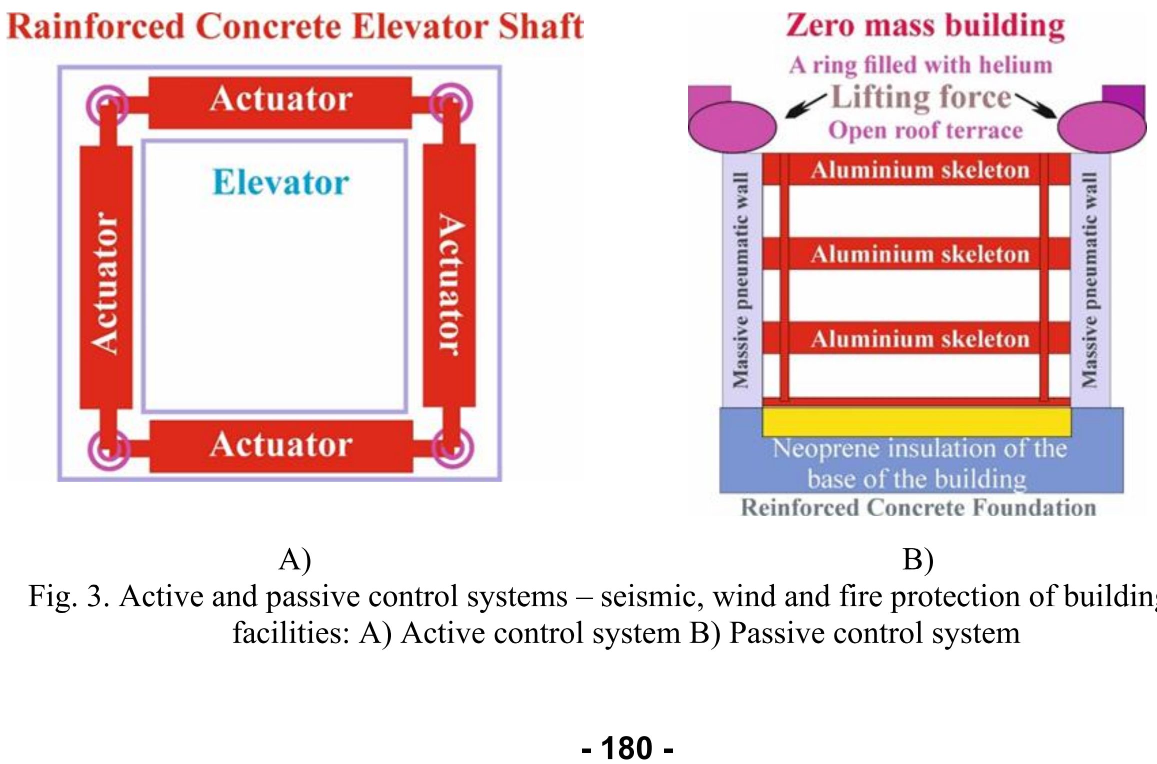
Fig. 1. Population of Bulgaria, according to census 2011 (Source: https://census2021.bg/)

Fig. 2. Population, Households, Housing of Bulgaria (Source: https://census2021.bg/)

EXPOSITION

Contemporary anti seismic engineering monitoring for real time processing of building dynamical behavior. Contemporary anti seismic engineering monitoring for real time processing of building dynamical behavior is developed in this report (all reference sources). Proposed national neuron network can be used in addition for seismic engineering monitoring by elevator devices improvement. Velocity sensors, mounted in elevator shaft have negligible low price and they elaborated in a real time frequency analyses of seismic signals in the reminded building as an addition digital result of the system. The amplitude frequency transfer function is important engineering data for the building response under seismic and wind dynamical loadings. This data is elaborated of each computer of the building under investigation. In the network all several million results of elevator devices are taking into account in real time for seismic or wind dynamical loadings for the seconds.

Active and passive wind and earthquake protection systems. These systems are the main part of the proposed national neural network for wind and earthquake protection based on the renovation of the existing elevator devices. The active control system mounted in reinforced concrete elevator shaft is presented in the Figure 3 A. The passive control system is presented in the same Figure 3 B.



A) B)

Fig. 3. Active and passive control systems – seismic, wind and fire protection of building and facilities: A) Active control system B) Passive control system

Structural Modal Analysis. On the Figure 4 and Figure 5 are given the Structural Modal Analysis for the Example building. Example building and Eigen-modes and Eigen-periods in the Figure 4 and Figure 5 are calculated by SAP 2000 (Natarajan, V., P. Philipoff, V. Sreedharan, H. Venkatachalapathy, 2016) and Mat Lab (Jivkov, V., V. Natarajan, A. Paneva, P. Philipoff, 2017).

Early warning systems (Kalurachchi, Y., M. Indirli, B. Ranguelov, F. Romagnoli, 2014; Parushev I., B. Ranguelov, T. Iliev, E. Spasov, 2015). All known seismic early warning systems (SEWS) are based on the basic physical property of seismic wave propagation. Equation:

$$\frac{V_p}{V_s} = 2^{-\frac{1}{2}} \tag{1}$$

is the fundamental link on which kinematic SEWS functions.

Where: *Vp* - the velocity of the longitudinal P wave, km/s;
Vs - the velocity of the transverse wave, km/s

These velocities differ from the velocities of oscillation of the media through which the seismic waves travel. The oscillating speeds of the particles are much smaller. The relation between the velocities of the waves always exists in the rigid ideal body and is an immanent property of any perfectly elastic medium. P-waves have compression/extension motions of solid layer particles and travel parallel to the wave propagation ray.

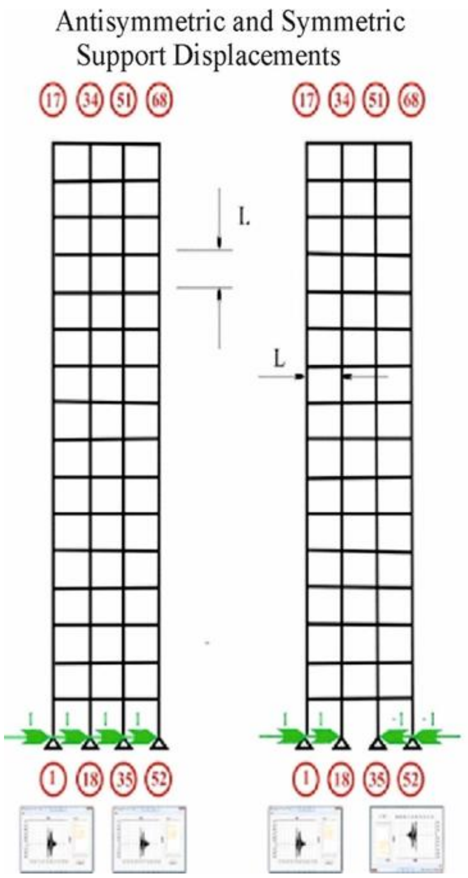


Fig. 4. Example building
Calculated by SAP 2000 (Natarajan, V., P. Philipoff, V. Sreedharan, H. Venkatachalapathy, 2016) and Mat Lab (Jivkov, V., V. Natarajan, A. Paneva, P. Philipoff, 2017)

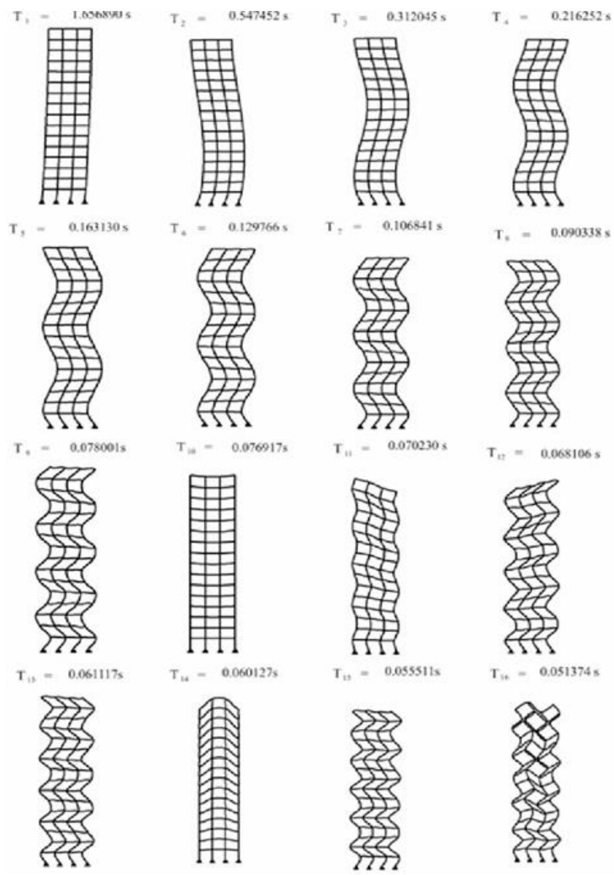


Fig. 5. Eigenmodes and Eigenperiods
Calculated by SAP 2000 (Natarajan, V., P. Philipoff, V. Sreedharan, H. Venkatachalapathy, 2016) and Mat Lab (Jivkov, V., V. Natarajan, A. Paneva, P. Philipoff, 2017)

These waves are the fastest and have the highest speed in the wave packet – between 6 and 8 km/s. P-wave amplitudes are often the lowest in the entire phase packet of any seismic wave emitted by the seismic source and have less destructive potential. S-waves – have several times larger amplitudes, a much smaller speed in the wave packet 1-2 km/s but a much greater destructive potential due to the movement of the particles of the medium, perpendicular to the propagation of the wave beam. S-waves do not propagate through liquids. Here, SEWS is used as network startup.

ILLUSTRATIVE EXAMPLE - SEWS - TRANSPORT CASCADE “SHIPKA”

Table 1. Seismic Outbreaks

№	Seismic Outbreaks	Coordinates φ[N]	Coordinates λ[N]	Depth [km]
1	Sofia	23° 20’ 00”	42° 40’ 00”	10
2	Kresna	23° 10’ 00”	41° 50’ 00”	10
3	Plovdiv	25° 00’ 00”	42° 10’ 00”	10
4	Gorna Oriahovica	25° 50’ 00”	43° 10’ 00”	10
5	Shabla	28° 30’ 00”	43° 30’ 00”	10

Table 2. Seismic Outbreaks

№	Seismic Outbreaks	Distance [km]	T_p [s]	T_s [s]	T_s [s]- T_p [s]
1	Gorna Oriahovica	70	13.6	20.8	7.2
2	Plovdiv	90	18.4	31.3	12.9
3	Sofia	180	30.0	51.8	21.8
4	Kresna	210	33.8	68.7	24.9
5	Shabla	276	42.0	53.0	31.0
6	Vranchea	380	55.5	99.8	44.3

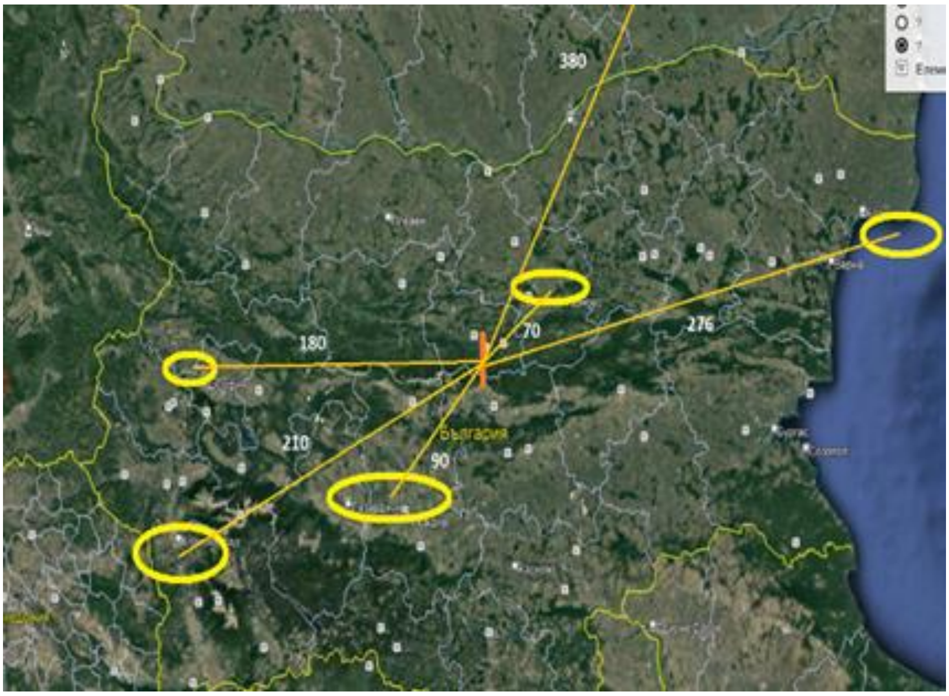


Fig. 6. Seismic outbreaks towards a future early warning system at transport stunt “Shipka”

An example of a technical solution for using the neural network of inertial motors for damping dynamic impacts from an earthquake or wind. Only an idealized example of a technical solution is presented here. The actual application requires a detailed engineering design for each specific building in the network according to the BDS.

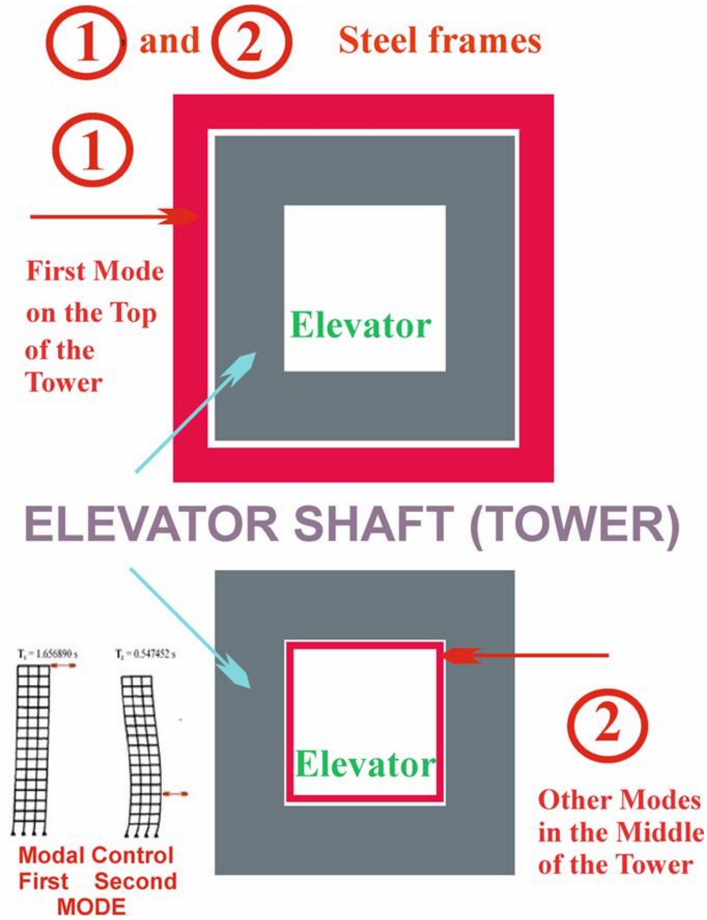


Fig. 7. Location of the inertial motors for the first and second modes of vibration (Fig. 2) for the example building of Fig. 1. Compensating the earthquake (wind) dynamic effects with inertial motors in the mode greater than 1 is associated with significant technical difficulties, affecting the final result insignificantly (less than 10 %). It is recommended to offset only the first form.

CONCLUSION

Three type of building with elevator devices are described in the report. Buildings up to 3 floors are very rigid and high frequency type. They have not necessity of dynamical protection. by neural networks. Buildings between 3 to 16 floors are of dynamic vulnerability type. They are of seismic vulnerability type. Buildings over 16 floors are of wind dynamical type.

Dynamic vulnerability type buildings are protected by neural network over the elevator renovation. Such a neural network guarantees 100% protection of people and animals in existing buildings with elevator devices during a hurricane wind or an earthquake of arbitrary magnitude, arbitrary duration and spectral composition of seismic signals. The system with passive control is also protected against fire. An addition result of the report is proposed contemporary anti seismic engineering monitoring for real time processing of building dynamical behavior. The cost of contemporary anti seismic engineering monitoring system is negligibly small. The main cost of the proposed neural network is not high because the elevator devices in the existing buildings are already built and functioning. The neural network is switched on through an early warning system (Kalurachchi, Y., M. Indirli, B. Ranguelov, F. Romagnoli, 2014; Parushev I., B. Ranguelov, T. Iliev, E. Spasov, 2015). The active inertial motors are powered by electricity and diesel generators simultaneously.

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