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МОДЕРНИ САТЕЛИТНИ СИСТЕМИ И УПРАВЛЕНИЕ НА СТРОИТЕЛНИ КОНСТРУКЦИИ

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MODERN SATELLITE SYSTEMS AND BUILDING STRUCTURES CONTROL

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Abstract:
The modern satellite systems allow to organized the continuous monitoring for key geophysical fields. They allow also to elaborate an assessment of local seismic activity in a given area of the Earth's surface. Together with the development of two types of modern building anti seismic structures, as follows: the passive control technologies and the structures with active dynamic response management, the modern satellite monitoring systems allow to solve the three essential problems of the modern scientific specializations as follows: engineering seismology and earthquake engineering:

- *to develop early warning systems and response;*
- *to estimate local seismic activity;*
- *to significant reduce of buildings and facilities seismic risk in case of strong earthquakes.*

Keywords:
Passive Control Technologies, Active Control Systems, Early Warning Systems and Response.

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1. INTRODUCTION

The temperature radiation (by the Outgoing Longwave Radiation method) is used for the earthquake forecasting. The data are obtained by satellite systems. Earthquakes with magnitudes M> 6 are investigated. The quantity criteria for earthquake forecasting estimation are elaborated in the study. The average of the output resistance is calculated for double year period [3], [4] before the crash for the specific areas of the Earth's surface (fair circle). Two values are compered in the study: 1) the average value for the double year period before the crash and 2) the instantaneous value of the emissions in the year of disaster occurred [15]. This comparison defines time interval. In this time interval is realized the most quantity energy, due collision between the earth plates.

The values of: coefficients of OLR variations, the maximum value of radiated energy [kWh/m2] and the time interval of disaster occurred are calculated for ten earthquakes.

Work hypothesis for strong earthquake forecasting [maximum value of radiated energy in kWh/m2 and time period in days] is presented in the study. This hypothesis is based on obtained results and trends [15, 16]. Since the beginning of this century (2000-2016) the humanity has suffered from dozens of destructive earthquakes with magnitude over $M \geq 6$, including two catastrophic earthquakes (Sumatra 26.12.04 and Japan 11.03.11) with magnitude over $M \geq 9$. They destroyed entire settlements and infrastructure - bridges, highways, roads, flooded islands, coastal harbors and power stations. The human victims amount to several hundred thousand. Material damages are in the same order reaching billions of dollars. The earthquake history constantly proves the unpredictability of power, place and time of the next cataclysm.

According to statistics, the number of devastating earthquakes increases over the time [1], whereas the geographical distribution is (Latitude, Longitude) predominantly in the “Fire ring” - along the boundaries of the main geotectonic plates and the fault lines. The process of occurrence of the cataclysm is probable. Some earthquakes forecast researches are given in [5], [6], [7], [9], [10], [12], [13], [14]. Teams from different countries are availing themselves of modern satellite technologies. Efforts are focused on studying changes in the ionosphere, underwater currents in the World Ocean, tides, electromagnetic emissions, thermal anomalies, etc.

In this study is presented information on the thermal anomalies (OLR) collected by the satellites during the earthquakes and from the past two years without earthquakes for the relevant geographic locations. It is known that the masses of the tectonic plates are subjected to enormous pressure and critical stresses are generated whereby positively charged particles “p-holes” are emitted. When these reach the ground, they ionize the molecules of the air and infrared rays are emitted. It is known as OLR. The satellite sensors at tens of kilometers catch the infrared radiation and keep track of it as a reflection from the Earth's surface with wavelength of 10-13 μm.

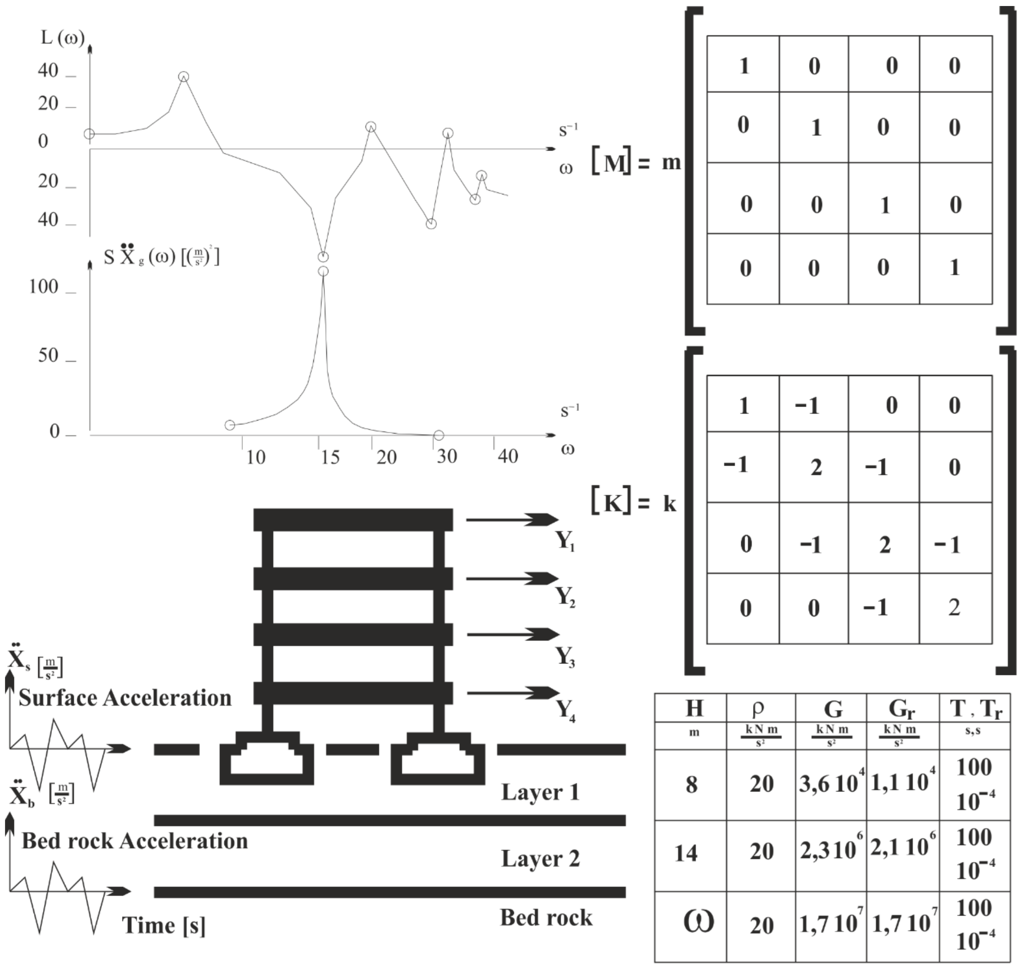

Figure 1. Passive control technology – idea solution [17].

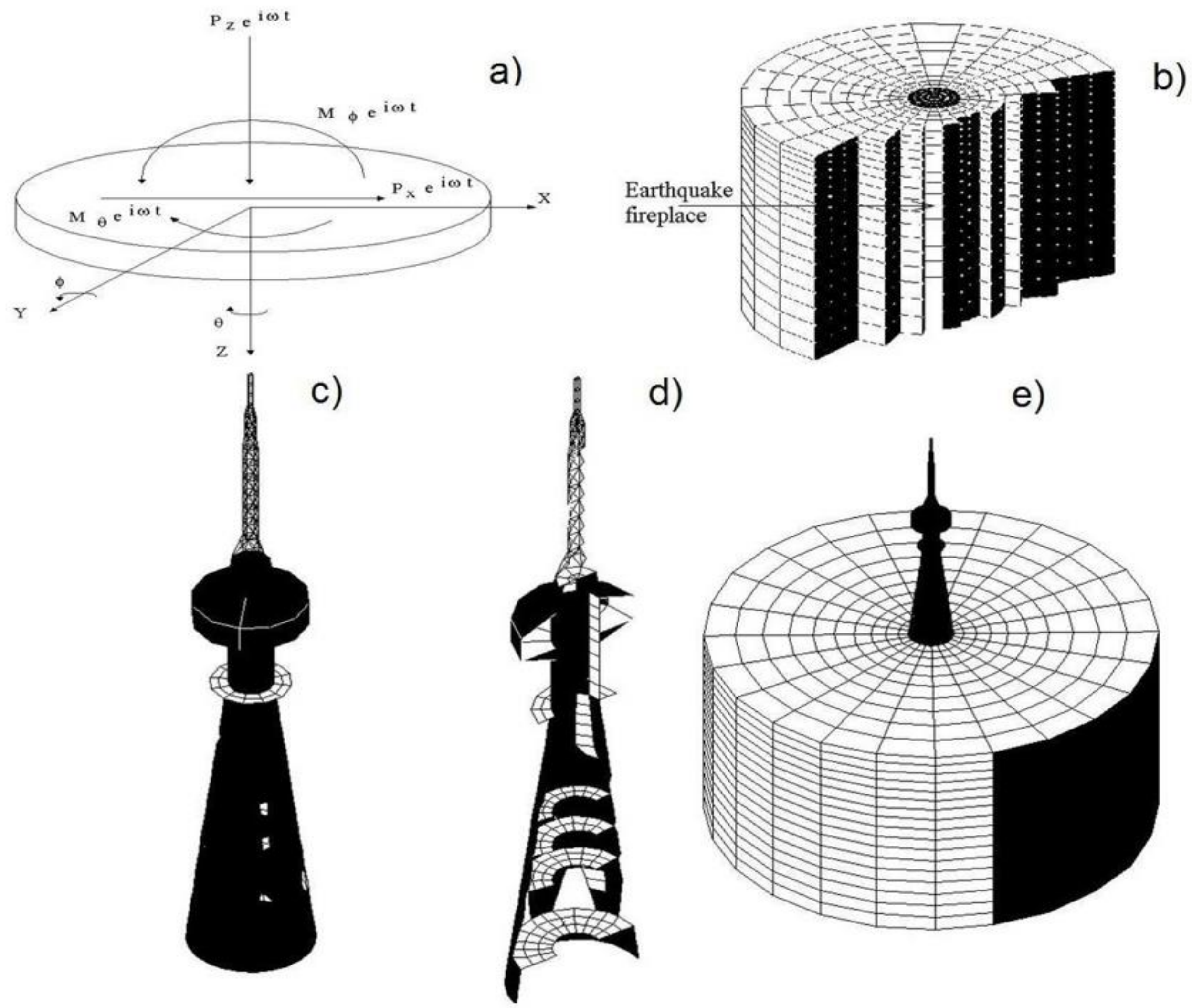

Figure 2. Active control technology – idea solution [17].

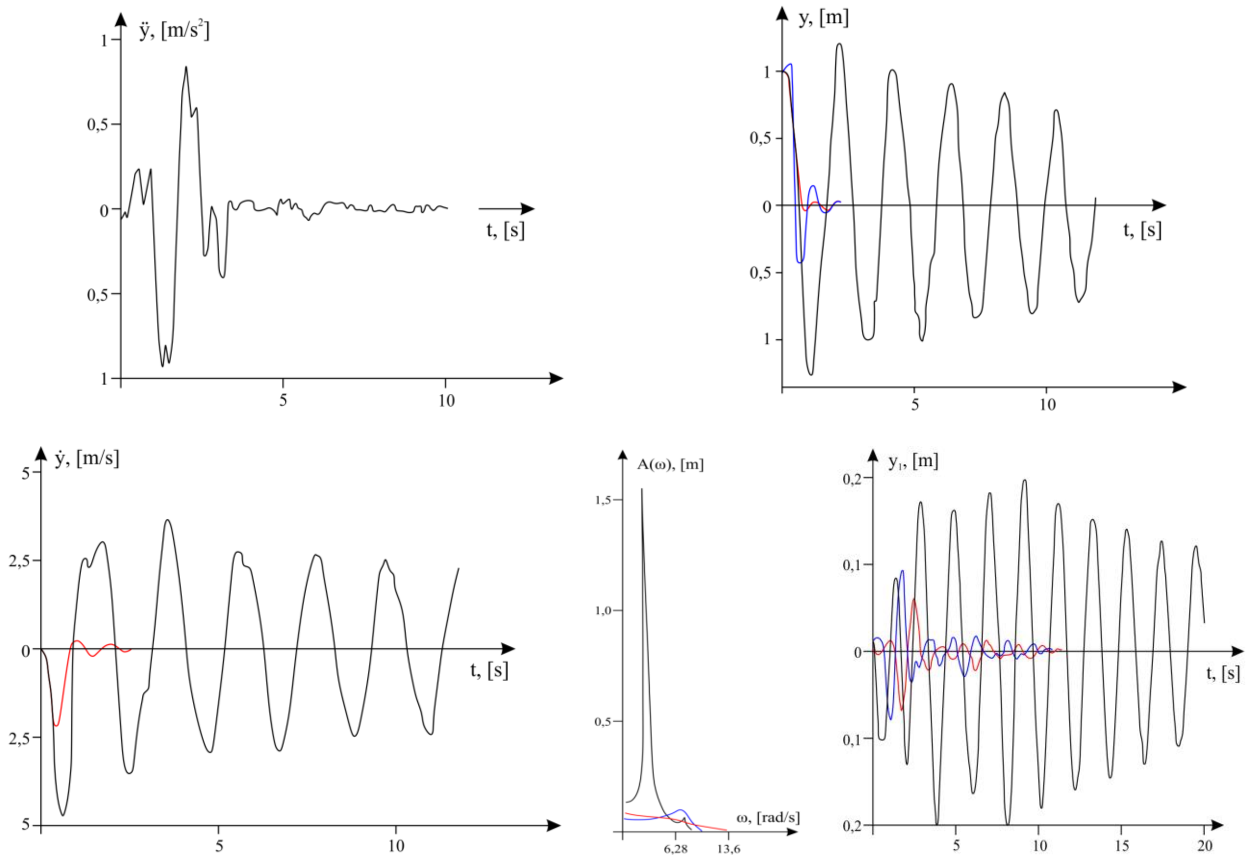

Figure 3. Active control technology – numerical solution.

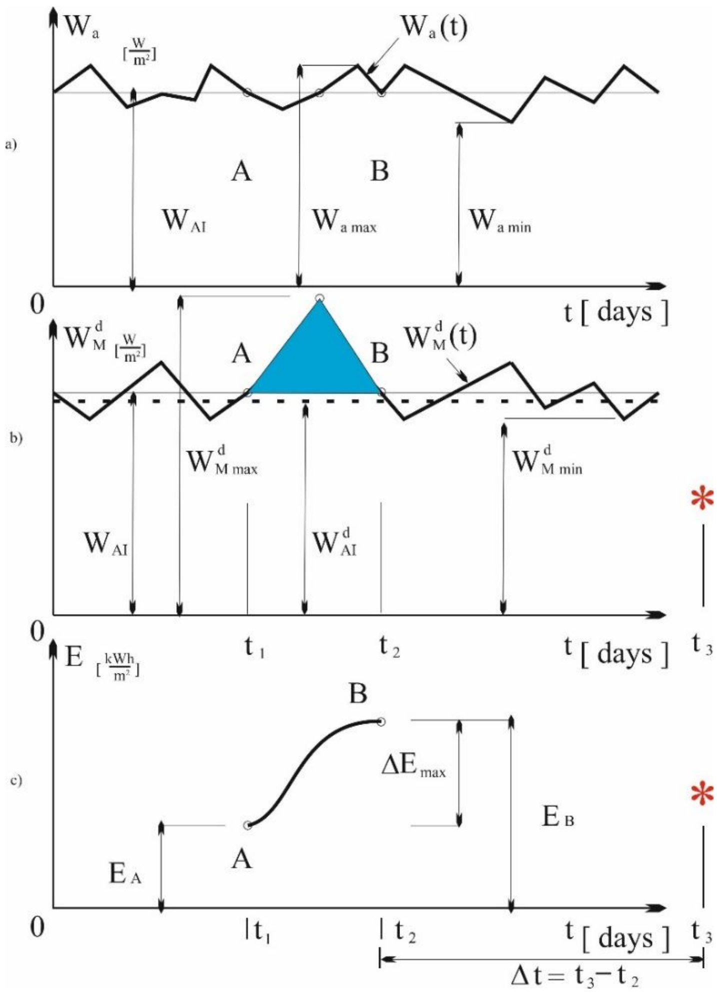

Figure 4. Principal OLR signals before a) and after b) a big earthquake
c) Change of energy ΔE_{max}

2. METHOD

The figure 4, a, b represents examples of variations of OLR signals. One of the figures represents variations of OLR signal WITHOUT any seismic phenomena for a two - year long period for the specific place on Earth with geographical coordinates – Latitude and Longitude. The other figure represents the OLR signal for the same place of the Earth with the same geographical coordinates, but for a time period of one year WITH occurrence of big seismic phenomena. The minimum and maximum values are as follows: W_{amin}, W_{amax}, W^d_{Mmin}, W^d_{Mmax}, and the average integral values are as follows:

$$W_{AI} = \frac{1}{T}\int_0^T W_a(t)dt \quad \text{and} \quad W^d_{AI} = \frac{1}{T}\int_0^T W^d_M(t)dt\,. \tag{1}$$

Extensive analysis (hundred occurred earthquakes with M > 6) shows that the difference between the average integral OLR signal values and the arithmetical average values is less than 5%. For this reason could be assumed that:

$$W_{AI} \approx \frac{1}{2}\left(W_{amin} + W_{amax}\right) \quad \text{and} \quad W^d_{AI} \approx \frac{1}{2}\left(W^d_{Mmin} + W^d_{Mmax}\right). \tag{2}$$

The variation of the energy of the OLR signal in the time interval $h = t_1 - t_2$ is shown in the figure 1 (c) where the variation ΔE_{max} is most significant. The points A and B match aligned values of:

$$W_M^d(t_1) \equiv W_{AI} \quad \text{hence} \quad W_M^d(t_1) \equiv W_M^d(t_2) \equiv W_{AI}\,. \tag{3}$$

The largest amount of change of energy ΔE_{max} in a year with an earthquake is determined by the expression:

$$\Delta E_{max} = \int_{t_1}^{t_2} W_M^d(t)dt - W_{AI}(t_2 - t_1), \quad \left[\frac{\text{kWh}}{\text{m}^2}\right]. \tag{4}$$

The extent of variation of the radiation during the period of two years without any cataclysms is δ_N [–]:

$$\delta_N = \frac{W_{amax} - W_{amin}}{W_{AI}} \approx 2\frac{W_{amax} - W_{amin}}{W_{amax} + W_{amin}}. \tag{5}$$

and the extent of variation of the radiation during the period with cataclysms is δ_d [–]:

$$\delta_d = \frac{W_{Mmax}^d - W_{Mmin}^d}{W_{AI}^d} \approx 2\frac{W_{Mmax}^d - W_{Mmin}^d}{W_{Mmax}^d + W_{Mmin}^d}. \tag{6}$$

3. RESULTS

Numerical energy indicators for forecasting of strong earthquakes – main results of the study presented by the maximum values of energy change ΔE_{max} [kWh/m^2] and time in days after ΔE_{max} occurrence as well as the variation δ_N before and δ_d during the disasters.

	Time	δ_N	δ_d	ΔE_{max}	Δt	M	W_{AI}	H	Latitude	Longitude	Place
		[–]	[–]	[kWh/m^2]	[days]		[W/m^2]	[kM]			
	1	2	3	4	5	6	7	8	9	10	11
1	28.03.99	0,150	0,337	4,42	12	6,6	244	15	30,512	79,403	Uharanchal India
2	28.10.05	0,080	0,430	3,47	25	7,6	238	26	34,539	73,588	Indo-Pakistan border
3	21.09.09	0,080	0,147	5,20	06	6,1	252	14	27,332	91,437	Bhrtan
4	18.09.11	0,080	0,156	4,80	04	6,9	262	50	27,730	88,155	Sikkim-India
5	25.04.15	0,154	0,259	3,11	23	7,8	260	8,22	28,230	84,713	Lanying Nepal
6	12.05.15	0,136	0,344	5,25	31	7,3	257	15	27,808	86,065	Kodari Nepal
7	16.09.15	0,135	0,512	4,10 (4,79)	10 (10)	8,3	210	22,4	-32,560	-70,00	Chily
8	15.04.16	0,220	0,480	4,20	31	7,0	265	10	32,050	132,01	Kumamato-Shi Japan
9	16.0416	0,163	0,634	9,00	16	7,8	218	19	79,900	0,37	Equador
10	28.04.16	0,107	0,202	2,00	03	7,0	280	27	-16,07	167,39	Vanuato

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