ISSN 2227-6920

Research Bulletin SWorld

Modern scientific research and their practical application

Published by:

Kupriyenko SV *on* ***Project SWorld***

With the support of:

ODESSA NATIONAL MARITIME UNIVERSITY

UKRAINIAN NATIONAL ACADEMY OF RAILWAY TRANSPORT

INSTITUTE FOR ENTREPRENEURSHIP AND MOREHOZYAYSTVA

LUGANSK STATE MEDICAL UNIVERSITY

KHARKIV MEDICAL ACADEMY OF POSTGRADUATE EDUCATION

MOSCOW STATE UNIVERSITY OF RAILWAY ENGINEERING

Volume J21403

November 2014

Author(s), 'Title of Paper," in Modern scientific research and their practical application, edited by Shibaev Alexandr, Markova Alexandra. Vol.J21403 (Kupriyenko SV, Odessa, 2014) – URL: http://www.sworld.com.ua/e-journal/j21403.pdf (date:...) - *page - Article CID Number*.

This volume contains research papers of scientists in the field of Geology.

Published by:

Kupriyenko SV

*on **Project SWorld***

Telephone: +380667901205

e-mail: orgcom@sworld.com.ua

site: www.sworld.com.ua

Paper Numbering: Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication.

CONTENTS

J21403-001

Anakhov P. V.

HYPOTHESIS OF CHANGE OF SEISMICITY IN RESERVOIR'S DEPRESSING ZONE

State University of Telecommunications,
Kyiv, Solomenska 7, 03110

Abstract. In the present paper is formulated the paradox of change of seismicity in reservoir's depressing zone, whereby instead of the expected increase in the intensity of earthquakes sometimes is observed their decrease. Proposed an illustration of this phenomenon by means of comparing the intensity of earthquakes with the sum of "exchanged" seismic events.

Key words: hydraulic engineering, depressing zone, seismicity.

Introduction. List of reservoirs all over the world, which caused the change of the normative seismicity of local geological environment, counts 95 units with increased seismicity, but 8 – which showed decreasing of seismicity after filling [1]. Such uncertainty results of hydraulic engineering may cause a dilemma in its substantiation.

Methodology and results. Hydraulic engineering often in the local environment determines the intensity of earthquakes. This confirmed by observations in areas of reservoirs [1].

Given situation illustrates an example of increased normative seismicity in areas of hydropower plants of Russia (Table 1).

Table 1

List of Russian reservoirs with purpose of hydropower, filling of which has caused the increase of seismicity (in MSK-64 scale) of the local geological environment [2]

Reservoir	I_{norm}	I
Chirkey	7	9
Miatlinsk	7	9-9,5
Chirjurtskoe	7	9,0-9,5
Gergebil'skoe	7	8
Irganajskoe	7	8
Krasnopoljanskoe	7	9
Maykop reservoir	6	7,5
Belorechenskoe and Ganzhinskoe (Belorechenskaja hydroelectric power station)	6	7
Zaramagskoe	7	9
Irkutsk	8	8-9
Sayano–Shushenskoe	7	8
Krasnoyarsk	≤5	7
Boguchany	≤5	6-7
Zeya	6	9
Kolyma	6	7
Ust-Srednekan	7	8
Kama	≤5	6,5
Shirokovskoe	≤5	6

However, the seismogenic hydraulic engineering inevitably must initiate

decrease of the intensity of earthquakes (releasing of tectonic stresses in the local environment) due to their "exchanging" into a number of smaller earthquakes or aseismic faults. This position is confirmed by observations of reservoirs, which showed decreasing seismicity after filling [1].

The purpose of the article is to explain an identified paradox.

It is proved that the increase (increment) of seismicity ΔI is due to changes in soil conditions of the site and is defined as [3]

$$I = I_{norm} + \Delta I \,, \tag{1}$$

where I_{norm} – normative seismicity of area of hydraulic engineering.

If submit a normative seismicity as seismic action of forecasted strong earthquake with a recurrence once during certain interval of time [3], then the formula (1) can be rewritten as follows:

$$I\left(\Delta t_{norm}\right) = I_{norm}\left(\Delta t_{norm}\right) + \Delta I\left(\Delta t_{norm}\right), \tag{2}$$

where $I_{norm}(\Delta t_{norm}) \approx const$ – intensity of forecasted strong earthquake during the time interval Δt_{norm} (500 years or 5000 years, or whatever).

Let's define the seismicity I in depressing zone of reservoir during time interval of the release of tectonic stresses Δt as the sum of single seismic events with intensity I_j:

$$I\left(\Delta t\right) = \sum_{j=1}^{k} I_j \,,\ \ j = \overline{1;k} \,,\ \Delta t = t_1 - t_0 \,,\ t_1 > t_0 \,. \tag{3}$$

For the case of single events with equal energy, formula (3) can be rewritten as

$$E\left(\Delta t\right) = kE_j \,, \tag{4}$$

where $E=f(I,D)$ [4]; D – depth of the earthquake source.

In Fig. 1 shows a family of lines of total energy of earthquakes in dependence on the amount of single seismic events with equal energy (seismic energy is calculated in accordance with Gutenberg–Richter law: $E(M)=10^{4,8+1,5M}$, where M – magnitude (units) [5]).

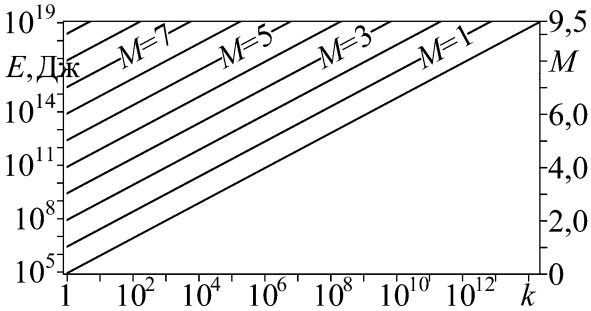

Fig. 1. Family of lines of total energy and magnitude of earthquakes in dependence on the amount of single seismic events with equal energy

Conclusion. Finally seismicity I in depressing zone of reservoir during time interval of the release of tectonic stresses Δt can be represented as the sum of "exchanged" seismic events:

$$\sum_{j=1}^{k} I\left(\Delta t\right)_j = I_{norm}\left(\Delta t_{norm}\right) + \Delta I\left(\Delta t_{norm}\right), \tag{5}$$

where $\Delta t_{norm}=\Delta t$ – reduced time.

This removes the contradiction between increasing of intensity of earthquakes after filling the reservoir, on one hand, and decreasing of intensity of forecasted strong earthquake due to its exchanging into a number of smaller earthquakes or aseismic faults. Fig. 2 shows the dependence of seismicity from the amount of single seismic events with equal energy, where k_0 – critical quantity of earthquakes, above which the seismicity in depressing zone seems to be decreasing.

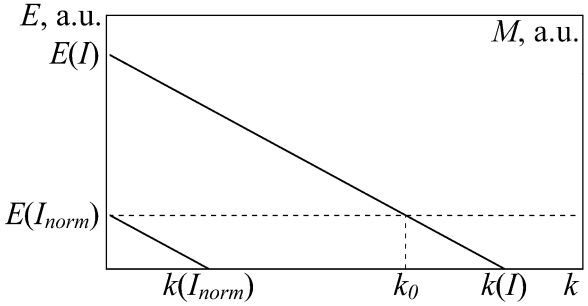

Fig. 2. Dependence of seismicity from the amount of single seismic events with equal energy

Literature:

1. Gupta H. K. A review of recent studies of triggered earthquakes by artificial water reservoirs with special emphasis on earthquakes in Koyna, India // Earth-Science Reviews. – 2002. – Vol. 58, No. 3. – P. 279-310.

2. Савич А. И., Бронштейн В. И. Современное состояние и пути обеспечения сейсмостойкости и гидродинамической безопасности крупных энергообъектов // Гидротехническое строительство. – 2000. – №8-9. – С. 60-70.

3. ДБН В.1.1-12:2006. Будівництво в сейсмічних районах. – К., 2006. – 170 с.

4. Медведев С. В., Шебалин Н. В. С землетрясением можно спорить. – М.: Наука, 1967. – 131 с.

5. Витязев А. В., Печерникова Г. В. Астероидно-сейсмическая опасность в третьем тысячелетии. Проблемы геофизики XXI века: в 2 кн. / Отв. А. В. Николаев. – Кн. 1. – М.: Наука, 2003. – С. 221-246.