4 2020

Newsletter #4

17 November 2020

This issue

Editorial and Organizational Development

Editorial

After a longer break we return to the regular publication of our newsletter. Purpose and topics of the newsletter will be changed. Besides the exchange of news about our organization the main purpose of the newsletter consists in providing information on interesting topics of general interest as well as on interesting scientific publications issued by our members. In a time of information floods and of fake news which have captured science, too, it is important to give orientation on scientific work which earns the attributes "scientific" and "of practical interest". The practical side of seismology is especially important. Only practical implementation of robust scientific seismological knowledge ensures the main goal of seismic hazard analysis and earthquake engineering – the prevention of future earthquake disasters. It is a long way to go because mainstream seismic hazard analysis has moved into a completely erroneous direction, making a very questionable PSHA technique to the national standard in many countries. Therefore, with this newsletter we return to the question how it was possible that this wrong direction in seismology was taken and what was the political and societal background for this unfortunate development.

Organizational Activities

Next General Assembly meeting:

The COVID-19 pandemic still hinders activities of many organisations. ISSO is also affected. If the situation will have normalized in 2021, we plan the next General Assembly meeting in Europe or by a video or phone conference in autumn 2021 including elections.

Website: www.issoquake.org

ISSO is still looking for a volunteer taking over the work on our website. After the unexpected surpassing of Indra Ghosh, the work on the website, which was performed voluntarily by his daughter, stopped. We plan to relaunch this work.

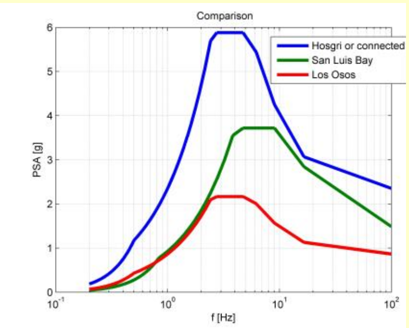
Charta: At the next general assembly meeting we plan to make the decision where and how to register ISSO as a non-profit nongovernmental organisation. Currently the affiliation of ISSO is Arsita, Italy. This affiliation was used by many of our members as affiliation in their publications.

Implementation of Scientific Strategy

Implementation of Scientific Strategy of ISSO

At the General Assembly meeting in Vienna 2016, ISSO members agreed on the scientific strategy for the next years. It was elaborated that the most feasible option for promoting the Intention of ISSO to represent the interests of public safety by being prepared for the worst credible event in combination with sound engineering consists in the support of the use of seismic intensities in seismic hazard analysis. For practical engineering applications it is important to provide a link between intensity and engineering parameters needed for safety and risk assessment (required by assurance companies). For this purpose, we must elaborate the link between seismological intensities, engineering site intensity factors (to allow for a decadal system), ground motion time histories and (if needed) corresponding response spectra. This link is needed, because single acceleration values like PGA or other single ground motion characteristics are not sufficient to explain the damaging effects of earthquakes and thus not suitable for a robust design. The wanted link between site intensity (or intensity factor) can be provided by linking intensities with time series either recorded ones or developed by waveform modelling like the NDSHA method matching the site intensity level. Furthermore, such a link between seismological intensity and engineering parameters must consider the variability (reflects the prediction uncertainty) of time histories within the margin of integer site intensity values. The conceptual idea of linking intensities with earthquake engineering consists in the development of a damage-consistent performance-based approach to the design of structures and systems allowing to grade seismic design requirements by the importance of the structure,

We have made large progress in implementing this conceptual idea publishing a set of papers by our members covering seismological and earthquake engineering topics of our strategy. We list some of them here:



Estimated seismic hazard for the Diablo Canyon Nuclear Power Plant from deterministic hazard analysis for different faults (MCE including safety factor), Klügel 2015b.

a) Klügel, J.-U., 2015a. Lessons not yet learned from the Fukushima disaster. Acta Geod. Geophys 50, pp. 5-19.

b) Panza G.F. and Bela J., 2020, NDSHA: a new paradigm for reliable seismic hazard assessment, Eng. Geol., vol. 275, pp. 1-14

c) Panza, G., Kossobokov, V. G., Peresan, A. & Nekrasova, A., 2014. Chapter 12: Why are the Standard Probabilistic Methods of Estimating Seismic Hazard and Risks Too Often Wrong. In: Earthquake Hazards, Risk, and Disasters. Amsterdam: Elsevier, pp. 309-357.

d) Klügel, J.-U., 2015b. On the Development of the Seismic Design Basis of Critical Infrastructures and Lifelines. Seismological Society of America Annual Meeting. Pasadena, SSA.

e) Klügel, J.-U., 2015c. Consideration of "Black Swan" Events in the Seismic Safety Review and the Seismic Upgrade Programme of Existing Nuclear Power Plants - the NPP Goesgen Example. Post-SmiRT23 Seminar, Istanbul, Turkey, October 21.23, 2015. Istanbul, SMiRT.

f) Klügel, J.-U., 2016. Risk and Hazard Assessment of Extreme Natural Events for Critical Infrastructures. International Journal of Safety and Security Engineering Vol 6 No. 2, pp. 96-103.

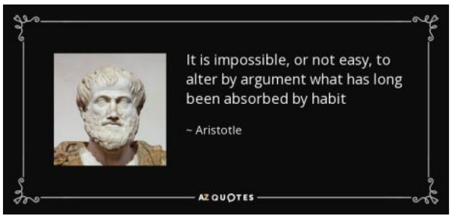
g) Stäuble-Akcay, S., Klügel, J.-U. & Nykyforchyn, A., 2017. Development of Damage-Consistent In-Structure Floor Response Spectra of Nuclear Power Plant Buildings, First International Conference on Seismic Design of Structures and Foundations, SeismiCon, December 10-12, London. London, Asranet.

The next large effort of our members to highlight the importance for a sustainable, robust approach to seismic hazard analysis and earthquake engineering consists in the ongoing book project to be published with Elsevier:

"Earthquakes and Sustainable Infrastructure: neodeterministic (NDSHA) approach guarantees prevention rather than cure" (Panza G.F., Kossobokov V.G., Laor E. and De Vivo B., Eds.)

The next step consists in a broader public communication of this strategy outside the range of scientists addressing decision makers and / or other non-governmental organisations. Our General secretary L. Mualchin has undertaken several steps into this direction by contacting and giving interviews to public media.

The decision of PG&E to withdraw plans to prolong the operation of the Diablo Canyon Nuclear Power Plant by renewing its operational licence for another 20 years is partially contributed to such activities. PSHA and the long-term Seismic Program for the Diablo Canyon Plant at the end failed to deceive the public. The awareness of the colossal risks associated with the operation of a nuclear power plant sitting directly on several active faults which may interact, has largely increased. But still the risk is there till the end of operation in 2024. A new Fukushima disaster can still occur.



Courtesy of J. Bela

Development of SHA – Part I – The rise of PSHA as part of the US Atomic Energy Programme

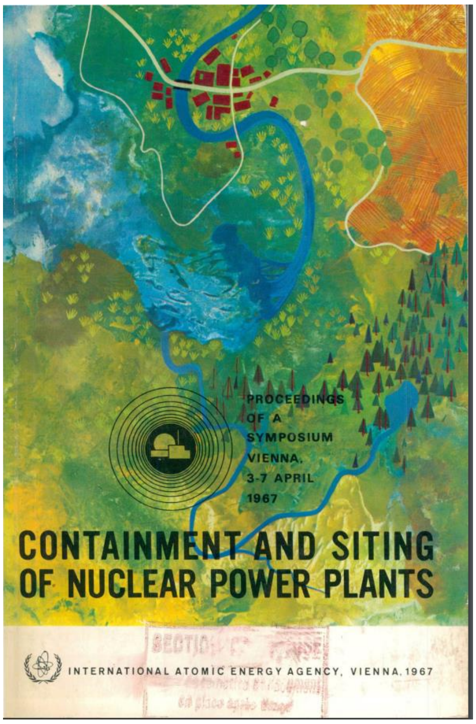
SHA – History Part I

It gets frequently forgotten that the development of PSHA was heavily promoted by the US nuclear industry and US nuclear regulators and somehow linked to the US atomic energy programme. From the U.S. the PSHA method was propagated into other western countries and finally also into the International Atomic Energy Agency (IAEA) safety guides. This is certainly not surprising, considering the political, technical and scientific dominance of USA in the nuclear sector. Internationally the civil use of atomic energy was started by the International Conference in Geneva in August 1955. Here the U.S. (President Eisenhower) agreed that countries which do not develop own nuclear weapons, are entitled to participate in the peaceful use of atomic energy and can have access to U.S. civil nuclear technology. The USSR at that time already developed own programmes for the civil use of atomic energy including the export of nuclear power plants to member countries of the Warsaw treaty. Under the impression of the use of nuclear weapons at Hiroshima and Nagasaki and the fallouts from nuclear weapon testing programs in the civil population there have been many concerns about nuclear power plants and the possible consequences of accidents. Therefore, the US Atomic Energy Commission (US AEC) and a special committee led by Edward Teller (the father of the hydrogen bomb) developed the first siting criteria for nuclear power plants. The core requirement of these siting criteria was that the potential radiological consequences of the most severe accident at the power station under the assumption of complete failure of all protection measures shall not lead to an inacceptable radiological exposure of the civil population. Soon it was observed that these criteria work reasonably well for small non-industrial reactors, but cannot be maintained for larger industrial reactors, or, the US AEC should have stopped the civil nuclear program due to the lack of suitable sites. Therefore, the rules had to be changed.

President Harry S. Truman signs the Atomic Energy Act of 1946

The change of rules was made in two directions:

1) "Deterministic" – a maximum design basis accident was postulated, and safety features were designed in a way that they were able to mitigate this accident even under the assumption of additional single failure assumptions without significant radiological consequences. For natural hazards like earthquakes, floods or high wind it was usually assumed that the largest historical event registered at the site shall not lead to a failure of the designated safety features. For earthquakes in many countries it was common to consider the largest historical earthquake and/or the largest fault being seismically active in the Holocene. The resulting forces were considered in the load case for the design of safety systems,
2) "Risk-based" – probabilistic – sites were regarded as suitable for nuclear power plant installations if the risk associated with their operation and measured by losses of human life is significantly lower than the risk from other comparable industries. This was the preferred approach, especially in the U.K and with some additional considerations (non-probabilistic approach to some natural hazards) in the U.S.A. This approach was widely internationally accepted by an International Conference of the IAEA in Vienna in 1967. The published by then Farmer's siting criteria, which were fully risk-based formed the basis for further development.



With respect to seismology the US position in 1967 was still mainly deterministic as was shown by the U.S contribution (Davies & Robb) to the Vienna conference although the high deterministic requirements were already considered as a burden:

SITING CRITERIA – A NEW APPROACH

F. R. FARMER
UNITED KINGDOM ATOMIC ENERGY AUTHORITY,
RISLEY, WARRINGTON, LANCS.,
UNITED KINGDOM

Abstract

SITING CRITERIA – A NEW APPROACH. The development of siting philosophies and criter during the past decade is reviewed. Experience in applying the criteria is described and the proble arising from their qualitative nature are examined.

A new quantitative approach developed by the United Kingdom Atomic Energy Authority and currently being applied to problems of reactor siting is described. It is shown how this approach ca facilitate assessment and lead to a quantitative criterion of acceptability.

SEISMOLOGY

Determining the seismic history of a specific plant site and the surrounding region and defining appropriate seismic design criteria to be used for conventional types of structures are established practices in the United States, which are done in accordance with generally accepted procedures. Public safety is involved in the seismic design of many types of structures, such as bridges, buildings, and dams, and the criteria and design of such structures are carefully reviewed to ensure that they will withstand the maximum earthquakes which can reasonably be expected at their location.

However, because of the conserative safety reviews which are made of nuclear plants in the United States, the tendency has been to require more stringent seismic design criteria for nuclear plants than for any other type of facility. Such conservatism reflects a concern with events having lower probabilities of occurrence than considered for other types of structures. Whether this practice is really justified is not at all clear, particularly when compared to dams, for example.

The request to consider less likely earthquakes (as phrased by Davies & Robb) put the question how to calculate the corresponding probabilities, of course, without disturbing the atomic energy programme to much. This task was fulfilled by A.C. Cornell with his research on "Engineering Seismic Risk Analysis" published in 1968. Reading his paper (BSSA, 1968) from the perspective of a professional risk analyst it becomes clear that Cornell did not bother much about the physical nature of earthquake occurrence. Geological and seismological features leading to earthquakes and the true partially cyclic and, nonstationary occurrence of earthquakes were simply ignored. He applied the same assumptions as in traditional reliability theory – events (earthquakes) are following a Homogeneous Poisson Process (HPP); thus, are stationary and non-cyclic. Using implicitly the theorem of Khinchine (the superposition of non-dominating stochastic processes asymptotically converges to an HPP) he, like many other (Knoppoff) could show correlation between earthquake occurrence (Gutenberg-Richter) and observed frequency for (and this was not mentioned) pooled and spatially extended data sets. By doing this he and his followers made the typical error of statisticians (I believe it was done intentionally to deceive the less educated public) taking "correlation" for "causality" or in other words taking made-up simplified models for the true behaviour of earthquakes. Seismic hazard analysis has not yet recovered from this mistake. In the next part of this series I will discuss the incorporation of subjectivism into PSHA.