Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)
©2014. Japan Geoscience Union. All Rights Reserved.

U09-01 Room:502 Time:May 1 14:20-14:45

Estimation of the paleotsunami size using tsunami deposits along the eastern Nankai Trough

FUJIWARA, Osamu[1*]

[1]Active Fault and Earthquake Research Center, AIST

Repeated great earthquakes (M8 class) and accompanying tsunamis occurred along the Nankai Trough have severely damaged the coastal areas along the trough. In response to the 2011 Tohoku-oki earthquake and tsunami, Cabinet office, Government of Japan came up with a new policy to the damage assumptions for the great earthquake and tsunami generated from this plate boundariy. That is, a doctrine that gives serious consideration to the greatest class of earthquake and tsunami, which take every possibility into account, was announced.

The announced "greatest class of earthquake and tsunami" along the Nankai Trough by the Central Disaster Management Council of the Cabinet Office (2011, 2012) has a rupture zone covering the almost entirely of the Nankai Trough (Mw 9.1) and is much larger than formerly estimated one. As this great earthquake and tsunami would hit the area with clustered population and industries, disaster prevention measure for these catastrophes increasingly attracts public attention.

Japanese historical documents cover the past 1300 year records of the great tsunami-inducing earthquakes generated from the Nankai Trough, so called Nankai and Tokai/Tonankai earthquakes. However, M9-class mega earthquake as mentioned above has never reported in this area. In considering whether out-sized earthquake and tsunami announced for the Nankai Trough will do occur or not, it is necessary to verify whether unknown out-sized earthquake has occurred in the geological time scale. Paleoseismological studies including the tsunami deposit researches are also needed to expand the time range of the earthquake and tsunami records beyond the historical documents and to make the reliable and realistic size estimation for the palate boundary earthquakes and tsunamis based on their recurrence history.

In reconstructing the paleotsunami size, it is needed to consider the influence of coastal geomorphic developments in centennial to millennium time-scale. Seaward expansion of alluvial lowland (migration of coast line) and coastal uplift are primary factors for these topographic changes, which can function as "natural barrier" for the tsunami inundation. For this reason, the older tsunami deposits tend to distribute the deeper inland and higher altitude. If the effect of these natural barrier is not considered, there is a risk that will come into the over estimation for the size of palerotsunamis. In considering the effect of natural barrier, tsunami deposits suggesting the out-sized earthquake have not found from the sedimentary sequence formed along the Enshu-nada and Suruga Bay coast in the last 4000-5000 years.

Keywords: Nankai Trough, Tokai earthquake, Tsunami, Tsunami deposit

©2014. Japan Geoscience Union. All Rights Reserved.

U09-02 Room:502 Time:May 1 14:45-15:10

Tsunami Sediment along the Nankai Trough and Nuclear Power Plants

OKAMURA, Makoto[1]*

[1]Science Research Center

We know well interplate megathrust earthquakes have been occurred repeatedly through several decades to centuries. Based on this common knowledge, huge earthquakes and tsunamis must be occured within a period of several thousand years. We research on tsunami sediment from lacustrine deposits along the Nankai Trough for prehistoric Nankai Trough Earthquake. As a result, large tsunami has been occurred 300 years interval through past 6,000 years. The Hoei Earthquake, AD1707 was the biggest tsunami through last millennium as mentioned after ancient manuscripts. Nevertheless, over the Hoei Earthquake tsunami sediments were found in several cores collected from lacustrine deposits.

However, we only have poor knowledge about these interplate earthquakes through millennium. Actually, the Fukushima Accident after the Kashiwazaki, we cannot evaluate even small-sized earthquake (Mw6.8), and 3.11 tsunami. We, seismologists and engineers, said "out of image" just after 3.11 off Tohoku District Earthquake. Never say "safe or safety" again about future earthquake and tsunami related nuclear power plants.

Keywords: mega-quake, Nankai Trough, tsunami sediment, nuclear power plant

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)
©2014. Japan Geoscience Union. All Rights Reserved.

U09-03 Room:502 Time:May 1 15:10-15:35

Change of giant tsunami study and the risk evaluation of the NPP before and after the 2011 Tohoku earthquake

OKAMURA, Yukinobu[1*]

[1]The National Institute of Advanced Industrial Science and Technology

When the 2011 Tohoku earthquake occurred, the study of the 869 Jogan earthquake by AIST has finished the first stage and the evaluation of the Jogan earthquake was almost concluded in the Headquarters for Earthquake Research Promotion, and also the back check of nuclear power plants seem to have been slowing down.

The study of Jogan earthquake by AIST started 2004 and was included in the project supported by MEXT from 2005 to 2009. The final report of the project submitted to MEXT in 2010, which concluded that a giant tsunami was generated during the AD869 Jogan earthquake which was larger than M 8.4 based on tsunami deposits survey in the Sendai and Ishinomaki plains, and that the recurrence interval of the giant tsunamis was 450 to 800 years. The AIST study team understands that the source area could extend to the north and south because the survey area of tsunami deposits was insufficient, and tsunami inundation was wider than the distribution of tsunami deposits. The survey of tsunami deposits of wider area had been started from 2010, but it was difficult to find coastal plains which preserve tsunami deposits.

The re-evaluation of all of the nuclear power plans started in 2007 based on new criteria of the safety assessment. The plants were evaluated by three sub-committees and the result was reported to the joint committee. Evaluation against strong motion by earthquake was preceded putting tsunami evaluation off later. In 2009, the middle reports of the Fukushima No.1 NPP was submitted to the joint committee which did not mentioned to the Jogan earthquake, and then only the minimum model of the Jogan earthquake was evaluated. The further discussion of its magnitude and tsunami has not been conducted before March 11, 2011.

The study of Jogan earthquake have been presented in meetings of earth science societies by AIST and medias reported several times since 2005, but the possibility of giant earthquake along the Japan trench was not discussed in the community of earthquake science. In addition, it is not easy to change the society that was not ready to giant earthquake. In these circumstances, nuclear power plants were working during the re-evaluatio, while many problems have been pointed out.

The situation has changed dramatically after the 2011 Tohoku earthquake. Society shares sense of crises against giant tsunami. The tsunami assessment has been made not based on known maximum earthquakes but unknown possible maximum. The safety of nuclear power plant were in doubt and the operation can be started after the safety of the plant was confirmed. Government dose not hesitated to assume maximum earthquake and tsunami, then possibility to point put unknown giant tsunami has been declined. But there is still unknown in earthquake, so it is necessary to continue study and to tell the society truce what we know and do not.

Keywords: tsunami deposits, giant tsunami, Jogan earthquake, Tsunami evaluation

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)
©2014. Japan Geoscience Union. All Rights Reserved.

U09-04 Room:502 Time:May 1 16:15-16:40

Strong motion characteristics of Mega-Thrust earthquake and the seismic response of NPP as a massive, stiff structure

KAWASE, Hiroshi[1*]

[1]DPRI, Kyoto University

The 2011 Tohoku earthquake generated a large number of strong motion records with high acceleration at many observation points, mainly in Miyagi and Ibaraki Prefectures. The distribution of seismic intensities observed or collected by JMA shows that intensity 7 was recorded only at K-NET Tsukidate (MYG004) in Kurihara City, but that intensity 6 upper were recorded at 40 points in four prefectures. When we compare the distribution of the peak ground acceleration (PGA) and velocity (PGV) of the strong motion records observed by K-NET and KiK-net of NIED with the empirical attenuation relation of Si and Midorikawa we can see that PGAs exceeded 500 Gals extensively along the coast from the Central Sanriku to Ibaraki Prefecture, but that PGVs in the area were lower than 80 cm/s. Because of the stochastic nature of the strong motion generation from the large-sized ruptured area there is no site with the coherent intermediate-period (around 1 s) velocity pulse with PGA larger than 800 Gals and PGV higher than 100 cm/s, which is the primary reason for not having severe seismic damage onto the ordinary low-rise buildings.

Prof. Sakai of Tukuba Universiy investigated the structural damage around the site with JMA intensity 6 upper to find that there are no site with heavy damage. We also found that, by using the nonlinear response models which can reproduce the damage ratios caused by the 1995 Hyogo-ken Nanbu (Kobe) earthquake, the structural damage potentials of the observed strong motions were relatively minor for most of the sites. These facts suggest that the current ordinary buildings in Japan, which is basically designed by using the rigid-structure concept, are capable to survive to the strong shakings from the mega-thrust earthquakes.

On the other hand the structural damage prediction by the Cabinet Office of the Japanese Government is made from the empirical relations with respect to seismic intensities of the predicted strong motions. Since such empirical relationship are all based on the damage observed during the 1995 Kobe earthquake, the relationship is good for the inland earthquake but not appropriate to the strong motions pervasively observed during the mega-thrust earthquakes with high PGAs but not so high PGVs. To prove this we independently predict strong motions and using the nonlinear response models we estimated structural damages and found heavily damaged sites only close to the shore line with soft ground conditions.

The same kind of smaller responses were predicted for the nuclear power plant (NPP) structures by using the strong motions predicted by the Cabinet Office in 2003 (Seckin et al., 2008, WCEE). The response of the NPP for predicted strong motions were about twice larger than the elastic limit of the structure, in terms of the relative shear deformation ratios. This is because on one hand the rigid body design concept makes structures sufficiently strong to the high PGA input and on the other hand the elastic limit used for the design is quite low compared to the ordinary buildings. Thus from the structural point of view strong motions during future mega-thrust earthquakes would not be a primary risk for NPPs despite of the spectral amplitude higher than the design input.

Keywords: strong motion, Mega-thrust earthquake, Stiff structure, shear deformation

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)
©2014. Japan Geoscience Union. All Rights Reserved.

U09-05 Room:502 Time:May 1 16:40-17:05

Safety regulations of nuclear power plant for tsunami after the 2011 great Tohoku-oki earthquake

TANIOKA, Yuichiro[1*]

[1]Institute of Seismology and Volcanology

Due to large tsunamis caused by the 2011 great Tohoku-oki earthquake, at First Fukushima Nuclear Power plant, cores were melted and explosions were occurred. Many inhabitants are still evacuated now because of radioactive contamination on land. About four months after this accident, the Nuclear Safety Commission of Japan made the committee for earthquake and tsunami related regulation guidance. In the committee, the revision of the earthquake-resistant design examination guidance was discussed. Before the accident, tsunami was treated as "consideration for the earthquake accompanying phenomenon". In the new guidance, "the safe design policy for tsunami" became an item different from "the earthquake-resistant safe design policy". In March, 2012, a new examination guidance including the safe design policy for tsunami was made.

Then, in September, 2012, the Nuclear Regulation Authority was newly established in Japan. Under the Authority, "the study team on the regulatory requirement for light water nuclear power plants - earthquake and tsunami ?" was established. The study team discussed about "new safety design standard for earthquake and tsunami". That was finalized in June, 2013.

In this new safety design standard, concept of the multiplex defense is adopted. 1) Tsunami should not get into a site. 2) When a tsunami get into a site with any reasons, the tsunami should be protected from a house or constructions. 3) When a tsunami get into a house, the power should be supplied from higher place near a site to prevent a severe accident. For tsunami should assume the largest tsunami source from the largest expected event. It is important to understand the concept of the multiplex defense. Some people may think that it is OK to have small inundation from small holes because the houses are protected from water. If such a thought comes out for the multiplex defense, a risk may increase ironically. I wish that the concept of the multiplex defense should be applied closely.

©2014. Japan Geoscience Union. All Rights Reserved.

U09-06 Room:502 Time:May 1 17:05-17:30

Seismic Safety Regulations and Earthquake Science

KOKETSU, Kazuki[1*]

[1]Earthq. Res. Inst., Univ. Tokyo

The first parts of seismic safety regulations for nuclear power plants consist of seismic and tsunami hazard evaluations as in the regulations for other structures. Although there are probabilistic and scenario assessments for the seismic hazard evaluation, the scenario assessment is mainly used and the probabilistic assessment is only in auxiliary use to evaluate remaining risk. Therefore, knowledge of earthquake science mostly contributes to making choices of scenario earthquakes in the scenario assessment.

This presentation mostly discusses the seismic hazard evaluation for nuclear power plants as the conveners requested, but also discusses the tsunami hazard evaluation as related to large subduction zone earthquakes. In addition, various phenomena occurring at nuclear power plants due to the 2011 Tohoku earthquake and their relation to these hazard evalutions and choices of scenario earthquakes are discussed.

We finally show from the above that the earthquake science cannot contribute to the real safety of a nuclear power plant unless unknown phenomena can be foreseen. We also discuss the danger of the idea that real safety can be reached if ”decision is made without prejudice only from the scientific and technical point of view.”