

ERS Research Seminars Apr./2018 - Mar./2019

■ Schedule of research seminars

Schedule	Nakano	Kiyota	Kawaguchi	Koshihara	Meguro	Kuwano	Numada
5/18 (Fri)		○	○			○	
7/13 (Fri)	○			○			○
9/21 (Fri)				○	○	○	
11/9 (Fri)	○		○				
3/8 (Fri)		○			○		○

1st seminar on May 18th

【Kuwano laboratory】

Yu OHARA (M2)

Title : An investigation of ground arching based on model tests simulating cave-in formation

Abstract : In Japan, approximately 5,000 cave-ins occur in roads. Since they cause traffic disruption and hurt or even sometimes kill people, cave-in is a serious problem from the viewpoint of maintenance of roads. More than half of cave-ins in Japan seem to be initiated by old sewer pipes. Once sewer pipe is damaged, sometimes water leaks out from the damaged part and when the water returns into the pipe not only water as well as soil around the damaged part is drained out. As a result, cavity is formed. Repetition of same thing leads to growth of cavity and when the cavity approaches the surface, covering soil becomes insufficient to support its weight and traffic loads, and finally collapse. As the number of old sewer pipes is increasing, it is assumed that the number of cave-in will also increase in the future.

Local governments, which are responsible for maintenance of roads do not have financial margin to restore all the cavities. Therefore, the way to maintain roads efficiently is now socially requested and to establish the method it is significant to investigate the mechanism of cave-in formation. However, because of the necessity of urgent restoration, full research in the cave-in sites is usually skipped. Therefore, model tests are conducted in our lab to investigate the mechanism of cave-in formation.

In this study, focusing on the ground arching immediately before collapse, it is estimated that there is linear relationship between mean thickness of covering soil above the cavity and width of cavity immediately before collapse. It means that if the covering soil is thick enough compared with the width of cavity the cavity is stable, and vice versa. This relationship enables us to roughly judge whether a cavity is likely to collapse or not.

In the recent apprehension of active seismicity in Myanmar, earthquakes are considered amongst significant hazards and a number of cities are subjected to high seismic risk, therefore, its assessment could be innumerable in disaster mitigation. Seismic vulnerability assessment being an important component of risk, this study focuses on the development of fragility/vulnerability functions for reinforced concrete (RC) buildings in Yangon city. The non-linear static pushover analysis is carried out on a group of 54 RC buildings (39 low-rise and 14 high rise) by varying material strengths, where the relationships are developed based on capacity curves over demand spectrum with fixed performance points representing damage probability as a function of both spectral displacement and ground accelerations.

【Kuwano laboratory】

Itsuki SATO (M2)

Title : New insight into mechanism of landslide caused by loose volcanic soil

Abstract : Soil having a high void structure derived from volcanoes is distributed in various places in Japan, and it becomes a cause of some slope disasters. The past large-scale sediment-related disasters include Ontake land slide with a slack surface of loose pumice stone layer caused by the Nagano prefecture Western quake, gentle slope disaster caused by the pumice layer of Minamiaso village due to the Kumamoto earthquake, slope disaster of Izu Oshima where the slope that had been evaluated as safe in the hazard map collapsed due to the torrential rain caused by the typhoon, the case of Miyagi Iwate earthquake where sediment flowed over a long distance on a gentle slope with a gradient of 1 to 2° as a source of

loose non-plastic volcanic ash soil with cementation.

In this research, focusing on the fact that slope disasters such as muddy flow and long-distance flow are triggered by volcanic pumice layers with high void, we reproduced extremely loose soil with volcanic cementation by adding cement, and investigated its strength characteristics. The extremely loose structure soil with cementation showed a large negative dilatancy, a low Poisson's ratio and a high shear strength until failure of cementation. In the undrained compression test, after the shear strength reached a peak and the cementation was lost, a brittle behavior was observed in which the shear strength converged to a residual value.

From the results of these experiments, we propose a new insight into mechanism that soil with high void causes slope failures.

【Kawaguchi laboratory】

Tomoe IIZUKA (M2)

Title : Preliminary study by dynamic numerical analysis of behavior of safety nets for accidental fall of non-structural components (suspended ceiling)

Abstract : Ceiling collapse suddenly occurs, not just during earthquakes. Putting safety nets under the ceiling is one method of prevention, which can preserve the environmental functions of original ceiling such as thermal insulation, acoustics and lighting. We, Kawaguchi lab, conducted ceiling drop tests to the cable-nets, and grasped the mechanics of safety nets. However, it's difficult to predict and grasp the mechanics of the various safety nets because the conditions of experiments are limited. Therefore, it's necessary to grasp mechanics of the various safety nets by numerical calculation. In this research, I check the validity of dynamic numerical analysis using LS-DYNA and calculate the motions of safety nets in various cases. Details of the contents of this presentation are shown as follows.

1. Validity of dynamic numerical analysis

To check the validity of dynamic numerical analysis, I compare the results of foregoing experiments with the results of dynamic numerical analysis using LS-DYNA. First, I calculate the simple models, dropping a weight to a single wire, and compare the results with foregoing experiments1). Next, I calculate the complex models, dropping a ceiling to safety nets, and compare the results with foregoing experiments2).

2. Numerical Investigation

I calculate the motions of safety nets in various cases. In this presentation, the relationships between maximum displacement at the center point or maximum reaction force at the support of boundary cable and size or mass of ceiling are shown.

References:

- 1) Hiraki T.: Preliminary Research of Shock Absorbers in the Safety Nets for Accidental Fall of Heavy Ceilings, Master's thesis of The University of Tokyo, 2017.3 (published in Japanese)
- 2) Nishizaki K., Kawaguchi K., Hiraki T.: Preliminary Study of Mechanism of Safety Net as Prevention for the Failure of Non-structural Components Part2: Comparison of Drop Experiments and Static, Summaries of technical papers of annual meeting Architectural Institute of Japan, pp.813-81

【Kiyota laboratory】

Muhammad UMAR (D2)

Title : Investigation of shear banding in sand by 3D digital image correlation in torsional simple shear apparatus

Abstract: The failure of granular materials is associated with the development of localized sheared zones accompanied by the large ground deformation during earthquakes. These localized zones became one of the major contributors to the global loss of strength. Therefore, to use reliable strength parameters, in this study a non-contact optical method applying three-dimensional digital image correlation (3D DIC) by using a Single-Stereo Camera system was developed and employed to capture and measure the full deformations of the specimens of dry and saturated Toyoura sand. Observations of the full field of deformation of the specimens by 3D DIC showed that strains developed at different fashion and rate in the specimens of Toyoura sand within two main zones, i.e. localized zones (around and within prospective shear bands) and non-localized zones (outside shear bands). Quantification of shear strains in these zones indicates both a large irreversible strain accumulation taking place progressively in the localized zones, initially at a lower rate and then faster as the number of loading cycles increased.

2nd seminar on July 13th

【Nakano laboratory】

Yu FUKUTOMI (M2)

Title : Investigations on restoration decisions for tsunami-damaged RC buildings

Abstract : The coastal areas of the Tohoku region of Japan were damaged beyond the estimated level by tsunami waves generated by the 2011 Great East Japan Earthquake. After this disaster, various design measures were developed to reduce structural damage from tsunamis. In addition to this, significant non-structural damage was also observed on buildings in tsunami affected areas.

In case of reinforced concrete (RC) buildings, except for the damages to foundation structures (e.g. overturning, lateral movement, tsunami scour, etc.), the damages were observed mainly on the non-structural components (e.g. window glasses, partitioning walls, or equipment). According to “The guidelines for Post-Earthquake Damage Evaluation and Rehabilitation (2001)”, which provides the building owners with solutions (i.e. restoration or demolition), the damage rating of a building was made based only on the structural damage. Several buildings with minor structural damage were therefore rated as “slight damage”, even though they suffered severe damage on non-structural components.

In 2015, the guidelines were revised to take this into account. According to the revised guidelines, a new damage index of buildings considering non-structural damage due to tsunami is defined as the ratio of the highest number of inundated stories divided by its number of stories. In addition, the revised guidelines suggest that the solutions (restoration or demolition) of a building should be determined considering land-use plan described in the regional recovery plan of local government. To validate the new damage index for tsunami-damaged buildings, it has been examined by the field surveys. However, it is not clarified how the land-use plan may affect the solutions of a building.

This research aims to validate the new index using latest field survey results and to clarify the influence of the designation of the tsunami Disaster Risk Area on the owner’s decision (restoration or demolition), which is designated by the local government based on The Building Standard Law and restricts the new construction in the area. For these purposes, the current status (e.g. restored, demolished, etc.) of the tsunami-damaged RC buildings was surveyed, and then the ratio of restored buildings was compared with the new damage index. In addition, the relationship between the ratio of restored buildings and designation of the tsunami Disaster Risk Area is discussed.

The results find that the new index in the guidelines shows a good agreement with the ratio of restored buildings, but the designation was not found a major factor for the owner’s decision. These results imply that the owner’s decision is mainly governed by inundation height of their buildings rather than by the land-use plan.

【Koshihara laboratory】

Saki UCHIDA (M2)

Title : Structural Investigation and Analysis on Timber Houses in Yangon, Myanmar

Abstract : Myanmar lies in the complex boundary zone on the eastern edge of the Indian plate, and thus strong earthquakes often hit the country, such as August 2016 Myanmar Earthquake. However, until 1988, there had not been any regulations concerning seismic resistance and soil investigation, therefore most of ordinary buildings built before that time are now at risks, and Yangon is one of the biggest cities which contains many of these old buildings.

Traditional Myanmar houses often have a timber structure, and Koshihara laboratory has focused on an area, Sanchaung Township, where such type of old timber houses are getting together. From a structural viewpoint, they are mainly divided into four types; one-story timber houses, two-story timber houses, three-story timber houses, and one or two-story brick nogging houses in which vacancies of timber frames are filled with bricks.

In this research, we conducted a measurement survey on four two-story timber houses in Sanchaung Township area, together with the students from MES, Myanmar Engineering Society. We could find three characteristics compared with Japanese traditional townhouses; columns of balloon framing, nail joints without notch, and long structural elements with small section.

We also conducted a microtremor measurement on two houses, to grasp the natural frequency and vibration mode. As a result, the natural frequency is about 2.3 seconds [short direction], and 4.8 seconds [longitudinal direction]. Regarding the vibration mode, two translational modes are confirmed, though we need to discuss the effects of the extended parts or adjacent house's brick wall, for further understanding of vibration characteristics of those houses.

Through this research, we also had some workshops with Yangon Technological University, aiming at working together in the research activities and sharing the knowledge about Japanese strategies about seismic performances of timber buildings.

【Numada laboratory】

Chaitanya KRISHNA (Project Research Associate)

Title : Validation Metrics for GMPEs using Tokyo Metro Ground Motions Data in Tokyo

Abstract : In an appropriate design or redesign of structure, reliability studies of buildings and hazard assessment of a region, it is essential to know the potential seismic hazard of a site. Seismic hazard is characterised by the severity of shaking or ground motion, which in turn is dependent on various parameters such as the energy released due to the earthquake, the source to site distance and site condition. A ground motion can conveniently be described by the peak values of accelerations, velocities or displacements. Strong ground motions are recorded at various locations in Japan, while Tokyo Metro Corporation has also installed sensors at different Metro stations in Tokyo at different depths. These records with soil condition of the site could be used to develop a site consistent design accelerograms for a particular hazard. However, this information will be inadequate to have customized accelerograms for different seismic hazards. In its behalf, the authors intended to incorporate ground motion prediction equations (GMPE) or attenuation equations to estimate deterministic hazard at a specific site, which will be further used to develop site consistent accelerograms.

3rd seminar on September 21st

【Koshihara laboratory】

Naoyuki Matsumoto (Research Associate)

Title : Reed Screen Wall: A Lost Modern Plaster Work

Abstract : Since ancient era, yoshi, reed has been used as a sunlight screen, partition, and sometimes as a wattle like substrate of mud wall. However, in the modern era, reed screen was also used as a substrate of plaster wall. That kind of wall construction way is less known, because this type of wall has been believed to be just a cheap and inferior one, and also it is not used late years. In this research, we collected primary technical books about building construction and plaster works, and analyzed how the reed screen wall construction has changed. In addition, a reed screen wall found in an onsite investigation is introduced.

We collected about 20 books and architectural standard specification of plaster works published from 1875 to 1975.

In Meiji era, the first article about reed screen wall was found in Wayo Kairyō Dai kenchikugaku by Shiro MITSUHASHI, in 1904. In this book, he wrote about reed screen as the substitute of bamboo lath wall, and reed screen is bound with wires and directly plastered. In Meiji era, Toyotaro TANAKA wrote another specifications of reed screen wall, and in his article, a typical reinforcement of reed screen wall with steel wires appeared.

In Taisho era, Goichi TAKEDA published a book about the construction way of Japanese and western style houses. In this book, he first referred the usage in tea house and traditional style houses. In other book, Makoto YOKOYAMA's 'Structure of Architecture', we can speculate that there were a various reinforced way of reed screen wall at that time.

In Showa era, technical book for plasterer began to be published. Among them, Yoshizo NAKANISHI's 'Guidebook for Japanese and Western Knowledge of Plaster Work and Carving' became one of the most influential one. In this book, for the first time, three grades of reed screen wall were defined. It depends on the quality of reed, nail, wire, coatings. Furthermore, as a characteristic of reed screen wall, compared to timber lath and plaster wall, less cracking for bending force was pointed.

After World War II, Architectural Institute of Japan published a guideline for standard construction of plaster work in 1953. In this edition, reed screen wall had its position next to traditional mud wall. However, in the next edition in 1975, this wall was deleted and never adopted until now.

【Kuвано laboratory】

Troyee Tanu DUTTA (D3)

Title : Assessment of wave velocities of various granular materials using planar piezo-ceramic transducers

Abstract : The precise estimation of the wave velocities and stiffness of geomaterials is essential for the accurate design of structures as well as reliable geotechnical characterization of sediments. In the present study, disk-shaped piezo-ceramic transducers are utilized to determine shear wave and compression wave velocities at both isotropic and anisotropic stress states. Silica sand specimens were first isotropically consolidated to confining pressure of 100 kPa and elastic wave velocities were measured at different excitation frequencies. Samples were then monotonically sheared at a low strain rate while keeping the cell pressure constant, and wave measurements were performed at various strain levels during the shearing process. It is observed that wave velocities of specimens prepared at different void ratios tend to converge at a

large axial strain similar to the stress-strain relationship. The increment of normal stress component has a significant influence on compression wave velocity as compared to shear wave velocity.

【Meguro laboratory】

Hideomi GOKON (Research Associate)

Title : Remote sensing technology for tsunami disaster

Abstract : Remote sensing technology is effective to identify the extensive damage caused by a tsunami disaster. Among many methods that have been developed to detect building damage at a building unit scale, X-band Synthetic Aperture Radar (SAR) data has a high-resolution and is useful to investigate the detailed conditions of earth's surface while its coverage is relatively small. On the other hand, L-band SAR data has a lower resolution leading to the difficulties for detecting building damage while it can cover broad area. During the disaster, it is important to comprehend the damage in extensive areas in a short time, therefore it is necessary to develop a method with broad coverage with high ability to analyze. The primary objective of this study is to develop a method to estimate building damage in a tsunami affected areas using L-band synthetic aperture radar (ALOS/PALSAR) data. We developed a method by extending the previously proposed method for X-band synthetic Aperture radar (TerraSAR-X) data. Sendai City and Watari town in Miyagi prefecture where many houses were washed away due to the 2011 Tohoku earthquake and tsunami were focused. We verified that the function we developed indicated good performance in estimating the number of washed-away buildings, matching with ground truth data with a pearson's correlation coefficient of 0.97. The verification was conducted in another study area, and yielded a pearson's correlation coefficient of 0.87.

4th seminar on November 9th

【Kawaguchi laboratory】

Takaaki ENOKI (M2)

Title : Survey of underground shelters and preliminary research on blast resistance

Abstract : In Japan, natural disasters including earthquakes occur frequently and seem to be more diverse and intensified in recent years. Furthermore, threats such as terrorism, nuclear power plant accidents, or missile attacks from other countries also may be emerging. The government and local governments have been preparing measures in many ways so as to mitigate damage and protect people quickly. However, from the point of view of shelters, they are hardly safe enough for various disasters mentioned above, since in most cases light-weight enclosures such as school gymnasiums or community halls are used for refugee.

Meanwhile, there are large underground spaces in urban area. Underground space may have advantages of resistance to earthquakes, bomb attacks and nuclear radiation and its fallout. In fact, many shelters have been constructed in underground space to use such merits in foreign countries. By contrast, most underground spaces in Japan are not designed as shelters and often closed at the time of evacuation for people.

In this presentation, two contents, a survey of underground shelters and preliminary research on blast resistance of structures, are shown to investigate the availability of underground space as shelter.

References

[1] Smith, Hetherington(1994) Blast and Ballistic Loading of Structures, CRC Press

[2] Takeda, Kawamura(1985) Quantitative Estimation of Deformation and Fracture of Reinforced Concrete Structures Subjected to Explosion, Kogyo Kayaku Vol.46 No.4 pp.182-195

[3] Ohno, Fujimoto et al.(2011) Blast Resistant & Safety Engineering, Morikita Publishing

[4] Schweizerische Eidgenossenschaft Bundesamt für Bevölkerungsschutz BABS(2016) TWK 2017 Technische Weisungen für die Konstruktion und Bemessung von Schutzbauten

[5] Ichino(2010) 地中爆発における爆土圧特性および地下構造物の内部爆発に起因する爆発影響に関する研究 (Research on Characteristics of Ground Shock Pressure Induced by Buried Explosion and Blast Effects Induced by Internal Explosion in Underground Structures)

【Nakano laboratory】

S. A. M. Nassif Zubayer

Title : Seismic Provisions in Bangladesh National Building Code 2015 for RC Buildings and Comparison with the Current Japanese Building Code

Abstract : Bangladesh is located in a seismically active region. No severe earthquakes, however, occurred during last hundred years. There is, therefore, good possibility of occurrence of big earthquakes any time. The major cities of Bangladesh are densely populated and heavily built-up, and people in these cities are under serious threat of earthquakes. In order to enhance building safety, a new edition of the national code of Bangladesh named as ‘Bangladesh National Building Code 2015 (BNBC 2015)’ is in the process of being published soon.

This presentation intends to provide a summary on seismic provisions of BNBC 2015 and clarify some major differences

between BNBC 2015 and the current Japanese building code. The comparison has been made especially for RC buildings in terms of base shear requirement and nonlinear response design spectrum. At first, the components of design base shear and the base shear factor by 'Equivalent Static Analysis Procedure' provided in BNBC 2015 have been clarified. Its base shear factor has been then compared with that in the Japanese building code (route 3). The comparison shows that the Japanese building code demands approximately 5 or 6 times higher capacity than BNBC 2015. The investigations in this study find that this result can be attributed to the difference (1) in the elastic design spectrum of both codes and (2) in the response reduction factor R of BNBC 2015 and the structural characteristic factor D_s of the Japanese building code.

5th seminar on March 8th

【Kiyota laboratory】

Masataka SHIGA (D1)

Title : Correlation between shear wave velocity and the occurrence of liquefaction

Abstract : 2011 Tohoku earthquake struck the eastern part of Japan and caused severe liquefaction damage especially around the Tokyo Bay area. Table.1 mentioned that there were 76 points where FL (Factor of Liquefaction) was lower than one although the ground was not liquefied. Therefore, accurate liquefaction assessment has been required for establishing efficient countermeasure.

CPT (Cone Penetration Test), SPT (Standard Penetration Test) N-Value and shear wave velocity has an essential role in the evaluation of liquefaction resistance of an in-situ ground. Although some previous researches indicated that each method correlates with liquefaction resistance²⁾, it is still vague how and why shear wave velocity representing a dynamic characteristic in small strain level can affect the strength in large strain. The research object is to describe how shear wave velocity affects liquefaction resistance.

As of now, I succeeded to test drained monotonic loading with strain-controlled triaxial apparatus although the apparatus has still some mechanical problem. Fig.1 shows the result of the monotonic loading test on the condition that confining pressure is equal to 100kPa and relative density is equal to 47%. The measurement of volumetric strain, which is shown in Fig.2, seems to have some low-frequency noises. Therefore, I require to install the equipment or the programming code for noise cancellation.

References

- 1)Ishihara, M. (2013). “Efforts towards sophistication of ground liquefaction judgment”, Debriefing session for 2011 Tohoku earthquake. 2)Kiyota, T., et. al. (2019). “Using in-situ and laboratory-measured shear wave velocities to evaluate the influence of soil fabric on in-situ liquefaction resistance”, SDEE, 117, 164-173

【Meguro laboratory】

Hideomi GOKON (Research Associate)

Title : Towards a mathematical approach for estimating extensive tsunami damage with numerical modeling and remote sensing

Abstract : In this study, a function to estimate tsunami inundation depth using pre- and post-event high-resolution synthetic aperture radar (TerraSAR-X) data was derived and the performance was evaluated. After the tsunami disaster, it is important to identify an extensive impact caused by a tsunami disaster. Tsunami inundation depth is an important index to expect building damage because it has a strong correlation with the amount of building damage. However, it was difficult to estimate the tsunami inundation depth from satellite image. This study aims at developing a method to estimate tsunami inundation depth by integrating remote sensing technology and tsunami engineering. The method for estimating tsunami

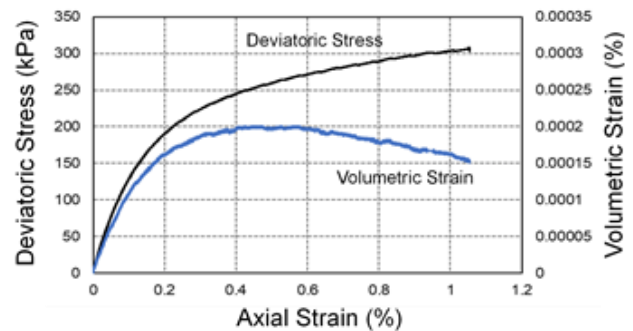


Fig.2 Stress-Strain relationship and axial versus volumetric strain comparison by strain-controlled triaxial apparatus

inundation depth consists of two steps, 1) Change detection of pre- and post-event TerraSAR-X data that captured affected areas due to the 2011 Tohoku earthquake and tsunami, 2) Estimation of tsunami inundation depth. The new function showed good performance with the correlation coefficient of $R = 0.68$.

【Numada laboratory】

Chaitanya KRISHNA (Project Research Associate)

Title : Development of site and scenario specific design ground accelerograms using recorded ground motions

Abstract : The response to ground accelerations are different at different sites corresponding to different soil conditions of the same bedrock motions, and this is mainly due to the soil characteristics of the site. In the field of earthquake engineering, it is essential to estimate the response directly or indirectly to estimate the seismic loads are agreeing to a particular site and scenario characteristics to ensure frequency characteristics of the local soil.

This study is a part of developing a methodology to generate a spectrum consistent earthquake design input motion using a database of strong ground motions, soil and soil profile. The database used is based on the sensors buried at different depths at various locations in Tokyo for 40 years by Tokyo Metro Co., Ltd. and the source parameters from Japan Meteorological Agency (JMA). Also, the local site conditions obtained from borehole data are substantiated to this database. Three approaches have been employed to establish a target spectrum. Firstly, using the average response normalised data and the design response spectrum at engineering bedrock, a site-specific design response spectrum is obtained. Secondly, using the average normalised data and Ground Motion Prediction Equations (GMPEs), modified for the designated locations and using deterministic source parameters, an amplified response spectrum is obtained. Finally, using normalised data and prescribed probabilistic seismic hazard and amplified target response spectrum is obtained.

Incorporation of ground motion characteristics has been done by using equivalent site response analysis for carrying out the convolution and deconvolution. The obtained target spectrums are then translated into design accelerograms using Ohsaki's method.