ERS Research Seminars 2017’

■ Schedule of research seminars on 2017’

Schedule	Nakano	Kiyota	Kawaguchi	Koshihara	Meguro	Kuwano	Numada
6/9 (Fri)			○		○		○
7/7 (Fri)	○				○		○
11/10 (Fri)		○				○	
1/12 (Fri)	○			○		○	
3/2 (Fri)		○	○	○			

1st seminar on June 9th

【Meguro laboratory】

Gadagamma Chaitanya Krishna（Dr.Eng.）

Title : Evaluation of Seismic Capacity of Existing Buildings in Developing Countries

Abstract :

Part A: Development of Earthquake Fragility Curves for Existing Reinforced Concrete Buildings in Yangon, Myanmar (Master research of Aung Ko Min, former graduate student)

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 innumerous 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.

Part B: Material Property Identification of Buildings using Modal Analysis

The rapid increase in the built environment and lesser frequency of earthquakes had let the communities to get complacent with the dwellings. However, with the urge to mainstream disaster risk reduction, it is now very important to assess and improve the capacity of the societies in principal. Typological studies suggest that Reinforced Concrete (RC) is amongst the most common and most vulnerable class of buildings. Thence, this research develops a new assessment methodology, addressing various problems and incompatibilities in the assessment. To assess the seismic vulnerability of a RC building, the first step is to assess the material properties of the building and it is done using the measured ambient response of the building different locations, with modal analysis and numerically the properties of the building is estimated by using a 'two step identification' technique. The direct application of this method has seen some limitations due to unknown masses in a structure, which has been addressed by estimating forced response at limited locations in the structure. Through this study, the feasibility study has been done to see the plausible applicability of this method to estimate the material properties with a theoretical case.

【Kawaguchi laboratory】

WANG PUJIN (D2)

Title : A Deep Learning Networks Approach to Damage Detecting System for Ceilings Using Convolutional Neural Networks

Abstract: Buildings with large span, like indoor stadiums in schools, are employed as shelters for residents when earthquake or other disasters occur in Japan. Fallings of ceilings or other hanging components in these buildings usually happen in a sudden and are dangerous to human body, especially when residents huddling to each other under these buildings during a disaster. Ceilings are vulnerable to many circumstances like earthquakes, ageing in the connection and miss in construction phase. Nowadays, damage detection of the ceilings due to material deterioration and safety reduction is mainly relied on human naked eyes. However, it is very difficult to detect possible damaged ceiling parts in a large range of ceilings such as ceilings of a gymnasium or a music hall. Moreover, the numerous varieties of the ceiling shapes and assemble methods also increase the difficulties of damage detection. An expert, a first class authorized architect in Japan for example, is frequently in demand to meet requirements in ceiling safety evaluation work. Substantially, damage detection and safety evaluation to the ceilings and hanging components can be transformed into computer vision problems. Applicable algorithms can process images of ceilings automatically. The prevailing deep learning method, especially the convolutional neural networks (CNN), is a potent algorithm to construct a damage detection system. CNN is a shared weights architecture in deep learning and is translation invariance. In this report, an architecture of deep learning model applying CNN is realized to evaluate the damage degree of ceilings. This trained deep learning model is utilized to predict the damage degree of new ceiling images. The results are also reported to

testify the model. In the discussion part, more detailed discussion to inspect every layer of the model is also performed to make a better understanding of this deep learning model.

2nd Seminar on July 7th.

【Meguro laboratory】

Kenjiro Yamamoto（D2）

Title : The development of a new fiber reinforced paint for seismic retrofitting of masonry structures

Abstract: We have seen a large number of fatalities attributed to earthquakes in the 20th and 21st centuries, and more than 60% of the fatalities have been caused due to the collapse of masonry buildings. To save the people living in masonry buildings, many kinds of techniques to seismically retrofit the masonry buildings were developed. However, the knowledge of the retrofitting techniques have not been spread in the countries where people still use masonry for housing. This is because most techniques require much time and labor work, and they need incentive to pay only for the value of seismic retrofitting.

To solve these problems, a new technique was introduced. A reinforced acrylic silicon paint mixed with glass fibers was used for retrofitting. This technique involves only coating the masonry building with that reinforced paint. Therefore, the time and labor required for retrofitting is considerably reduced. Furthermore, the reinforced paint can be introduced as a form of painting, which adds aesthetic approval to the masonry buildings. The past shaking table test has shown that the house retrofitted with the reinforced paint has large deformability and good energy dissipation capacity. However, the level of damage to masonry walls inside the coating of the paint is similar to that of masonry walls of an unreinforced masonry house, because the reinforced paint does not contribute to the initial stiffness of the house. Therefore, it is impossible for the residents to use the house retrofitted with SG-2000 after a large earthquake even if it saves their lives.

To solve this problem, the retrofitting needs to contribute to not only the deformation capacity but also the strength of masonry buildings, which can be solved by composite use of different kinds of paint. In this research, we conducted tensile tests using SG-2000 whose resin and ratio of fiber is changed to develop a new type of paint which improves the strength of buildings. Tensile tests of the new paint and in-plane tests are conducted using the composite use of the new paint and previously used paint.

【Nakano laboratory】

Tatsuya Asai (D3)

Title : Response Evaluation Method of Buildings due to Tsunami-Driven Ship Impact Loads

Abstract: The past tsunamis carried a huge amount of waterborne debris inland. Even massive ships were also carried by tsunamis, and some of them were reported to have caused critical damages to buildings. Although tsunami evacuation buildings (TEBs) need to be appropriately designed against the tsunami-driven ship impact loads as well as tsunami loads, the impact loads are not specified quantitatively in the current design guidelines for TEBs. The following three studies are therefore made to propose the design method of TEBs against the impact loads. Firstly, we investigated 143 ship behaviors during the tsunami event caused by the 2011 Great East Japan Earthquake, and concluded that the uncontrollable ships, of which drafts are less than tsunami inundation depth, should be considered as the potential impact load source. Secondly, four case studies were made on ship collisions with coastal structures observed during the tsunami event, and a rectangular pulse was employed as the ship impact loads considering previous theoretical and experimental studies. Finally, a simplified method to estimate the maximum building responses due to the above impact loads was proposed based both on the predominance of the first mode of building responses and the equality between external and internal works. The maximum building responses by the above proposed method were then found to successfully estimate those computed by dynamic response analyses.

3rd Seminar on November 11th.

【Kuwano laboratory : Ali Umair (D1)】

Title: Trapdoor model test and numerical simulation associated with arching

Abstract

The estimation of earth pressure exerted on underground structures is not easy due to complex interactions between soil and structure. The distribution of earth pressure varies with differential settlement around the structure. This contribution

assesses evolution of earth pressures acting on an embedded structure caused by differential settlement. A soil box with five base platens that can be lowered or uplifted separately, was developed to undertake trapdoor tests. A series of trapdoor tests was conducted to quantify earth pressures acting on the base platens while varying the burial depth and the density of Toyoura sand. The earth pressure acting on each platen was measured using load cells located inside each platen. Similar test condition was considered in equivalent discrete element method (DEM) simulations in which spherical particles analogue to soil grains were used. The DEM results capture the deformation characteristics of the ground and the pressure distribution on the bottom platens observed in the model tests. The evolution of strong contact forces during lowering the trapdoor was analysed and development of arching above the lowering trapdoors was confirmed.
Further to that, DEM simulations with half width factors compared to actual model tests were analysed and compared with the full width results. It was also observed that trapdoor interval (W/B ratio) is significant in the arch formation and stress distribution for the DEM simulations. Moreover, a series of triaxial compression tests was carried out on DEM samples so that essential parameters governing model test responses can be linked to fundamental material parameters, e.g. mobilized friction angles or dilatancy characteristics. To validate the DEM simulation results, additional experimental cases using spherical glass beads are under preparation. The influence of angular shape of real soil grains on the stress distribution around the buried structure will be discussed in near future.

Masahide Otsubo (Research Associate)
Title:
Particle-scale mechanics of dynamic wave propagation and small-strain stiffness of granular soil
– Experiments and Discrete Element Method simulations
Abstract
Soils are granular materials consisting of many particles, and the overall response of a soil can be a complex accumulation of the inter-particle responses. Small-strain soil stiffness is important to predict the ground deformation in situ and in practice and is often deduced from elastic wave velocity in laboratory experiments. The dynamic properties of soils are also important for dynamic analyses including site response analysis. Stress waves propagate through soil via the grain contact network, thus the actual particle-scale mechanics differ from those assumed in continuum mechanics which is often used to simulate and analyse stress wave propagation.
However, particle-scale responses of granular soil have not been fully understood. Discrete element method (DEM) is a powerful tool to analyse the particle-scale mechanics of dynamic wave propagation through an assembly. In this research, DEM simulations of planar compression/shear wave propagation were performed and compared to equivalent laboratory experimental data. Supplemental analyses, in addition to the DEM simulations, were also used to develop a more comprehensive understanding of the system dynamics. The assembly stiffness and mass matrices were extracted from the DEM model and these data were used in an eigenmode analysis that provided significant insight into the observed overall dynamic response. The close agreement of the wave velocities estimated using eigenmode analysis with the DEM results confirms that DEM wave propagation simulations can reliably be used to extract material stiffness data. The data show that increasing either stress or density increases the elastic wave velocity and allows higher frequencies to propagate through the media, but the low-pass wavelength is a function of packing density rather than stress level.

4th Seminar on January 12th

【Koshihara laboratory】

Naoyuki Matsumoto (Assistant Professor)

Title :

Building Construction and Seismic Performance of Walls in Modern Wooden Buildings; Composition and Seismic Performance of Lath and Plaster Wall

Abstract :

During the modern age in Japan (from Meiji Restoration to WW II in this lecture), several ways of constructing wooden architecture were newly imported and invented. Today in the increasing need of restoration of those modern wooden architectures, we have to trace the history of those construction elements and verify the seismic performance of them. The subject on this lecture is introducing the historical change and the structural performance of the shear wall used in those Japanese modern wooden architectures.

First, the typical type of shear wall in the era was found by analyzing the distribution of combinations of elements of the shear wall. For the analysis, we made the list of construction elements about 102 buildings by researching the reports of restorations of the important cultural properties. Then, the static loading tests to the full-scale model were performed to investigate the seismic performance of that type of wall. Details are as below.

1. Literature research of repair reports of national designated cultural properties was performed to verify the historical change of compositions and dimensions of walls in modern wooden buildings. The results of this investigation are, 1) in over about 70% of those buildings, lath and plaster walls, called ‘’Kizuri Shikkui’ are used, 2) there are three types of combination to put the lath board between pillars, 3) dimensions of Kizuri, substrates of those lath and plaster walls in those buildings are bigger than same substrates in these days.

2. Lateral loading tests to clarify the seismic performance of the lath and plaster wall were performed. The specimens were lath and plaster wall whose pillars were exposed, traditional mud wall. Compared with the traditional one, lath and plaster wall had almost the same initial stiffness, but brittle fracture tendency. Finally, we estimated two typical resisting mechanism of lath and plaster wall in case of the pillars are exposed, and proposed its analytical model.

【Kuwano laboratory】

Naoto Kominami (M2 student)

Title:

Study on the relationship between water passages and sinkholes

Abstract :

Sinkholes face a growing risk due to the increase in the number and intensity of extreme weather, which may lead to serious human casualties or physical damage depending on time and place. Therefore, it is important to investigate the cause of sinkhole accidents and take measures to prevent these accidents beforehand. It is known that sinkholes occur by the following procedure: 1, Water passage forms a cavity due to the erosion of soil. 2, Cavity develops and the surrounding soil loosens. 3, Soil above collapses resulting to sinkhole occurrence. Conventional methods such as penetration tests and seismic wave tests which focus on searching the loosening and cavities in the soil do exist, while these methods still leave room for improvement, in aspects such as accuracy and cost-effectiveness.

To complement these conventional methods, the objective of this research is to propose a new, simple, non-destructive ground survey method, focusing on identifying the water passages, and to consider the relationship between water passages and sinkholes. First, field investigations were conducted in 2 sinkhole accident sites in this research: Miyakonojo Miyazaki-prefecture, and Pokhara Nepal. Conventional surveys including penetration tests and surface wave surveys were conducted to understand the cavities and loosening underground the accident site. Underground water sound measurements were also conducted as new ground survey methods, which is a method that searches for water passages by detecting the sound of underground water.

Based on the resulting knowledge from the surveys, model experiments were conducted. Model tests using cylindrical soil tanks were conducted to understand the relationship between sinkhole parameters and water passages. Water sound measurement tests were conducted to understand the relationship between water passages and underground water sound.

Mayuko Hotta (M2 student)

Title:

A study on the development of subsurface cavity potential map in Fukuoka city

Abstract :

To prevent road subsidence, subsurface cavities have to be treated properly because a cavity becomes a sinkhole. The objective of this study is to develop a cavity potential map, which shows clearly the risk of having subsurface cavity in each place. It can be used to evaluate the priority of cavity survey conducted by local government, and using the map,

road survey can be conducted more efficiently.

In this study, data of subsurface cavities obtained in Fukuoka city were used. The data were compared with geographic or environmental factors, such as landform and underground structure, to assess the correlation between the potential of having cavities and those factors using GIS. According to the correlation and weighting among factors, a cavity potential value, which represents the possibilities of cavity was defined and calculated in each place in Fukuoka city. In this study, the target cavities were divided into two groups according to the mechanism of each cavity, which was estimated in Fukuoka city's report. Based on the correlation between cavity occurrence and geographical features obtained from the analysis of each group, two cavity potential maps were created. In addition, dimensions of target cavity were sorted out to grasp the image of target cavities

【Kawaguchi laboratory】

Yosuke Nakaso **(Assistant Professor)**

Title:

Research on the safety criterion for ceilings using a human head FE model; Ceiling material tests considering strain rate effect and validation of the human head FE model

Abstract :

Ceiling collapse occurs somewhere in the world in everyday life. However, there is no way to judge if existing ceilings are dangerous or not, and architects do not know how to choose the safe ceiling materials depends on their installation height when they design ceilings. We, Kawaguchi lab, conducted numerous ceiling drop tests to a dummy head from one to twenty meter height using various typical ceiling materials and measured the impact force to the dummy head to propose the safety criterion of the ceilings. According to this proposed criterion, the importance of lightweight ceilings are recognized and new products are being developed. To save labor for the drop tests and to consider various situations such as the ceiling size, it is attempted to evaluate the impact force of the ceilings by numerical analysis. In this presentation, two contents are shown to propose the more precise safety criterion as follows.

1. Ceiling material tests in the wide strain range

It needs to know the ceiling material property in the wide range of strain rate to simulate the ceiling drop tests by numerical analysis. Therefore, the compression tests were conducted by the several test methods: quasi-static loading tests, dynamic loading tests, and impact tests called the Split-Hopkinson Pressure Bar tests. According to these tests, the material property was obtained and the strain rate effect was confirmed.

2. Validation for the head FE model

To simulate the more realistic phenomenon of the ceiling impact to a human head, the three-dimensional digital human-head model developed by Watanabe et al.[1)] was used instead of the dummy head in the analysis of the ceiling impact. In this presentation, the results of comparison of an impact test to vertex of a human cadaver conducted by Yoganandan et al.[2)] and the dynamic analysis simulating Yoganandan's experiment using the head FE model for the validation of the head FE model are shown.

1) Watanabe D, Yuge K, Nishimoto T, Murakami S, Takao H: Development of a Human Head FE Model and Impact Simulation on the Focal Brain Injury, Journal of Computational Science and Technology, Vol.3 No.1, pp.252-263, 2009

2) Yoganandan N, Pintar F, Sances A Jr, Walsh PR, Ewing CL, Thomas DJ, Snyder RG., Biomechanics of Skull Fracture, Journal of Neurotrauma, Vol. 12, pp.659-668, 1995

5th Seminar on March 2nd

【Kiyota laboratory】

Presenter: Hiroki OKUDA

Title: Refinement and verification of liquefaction hazard map for road network in the Tokyo Bay area

Abstract: In the 2011 Off the Pacific Coast of Tohoku earthquake with a Mw of 9.0, liquefaction-induced damage occurred widely in the Kanto Region, Japan. Urayasu City, Chiba Prefecture, which is located along the Tokyo Bay had been reclaimed in since 1960's till 1980's, and approximately 85 % of the city were heavily damaged due to the occurrence of liquefaction. This study extracted values of ground subsidence at various locations in Urayasu City from the subsidence map prepared by air-born LiDAR survey. Given the extracted values of soil subsidence along different types of roads and liquefaction potential index, PL, calculated using borehole data, it is found that an increase in the road subsidence with an increase of PL value is more significant for the residential road than that for the main road. This study developed a new liquefaction hazard map based on the relationship between the extracted road subsidence and PL value. A comparison of the estimated subsidence in the hazard map and real damages was carried out in order to confirm an applicability of the hazard map.

Presenter: Yuta MAEKAWA

Title: Change in soil fabric of Urayasu sand specimen and its influence on shear wave velocity and liquefaction resistance

Abstract: The fabric of sandy soil samples retrieved by conventional "so-called" undisturbed sampling techniques is prone to disturbance, which may lead to test results that over or underestimate liquefaction resistance. Although there is an option to use a reconstituted sample as a substitute for the undisturbed sample, it is difficult to recreate the in-situ soil fabric for the reconstituted sample. In order to investigate the effect of soil fabric on the liquefaction resistance of Urayasu sand, a series of undrained cyclic triaxial tests and shear wave velocity measurements were performed, and then the results and those in previous literature were analysed. Finally, a method for evaluating liquefaction resistance based on the in-situ and laboratory-measured shear wave velocities is proposed.