1. OBJECTIVES AND RESEARCH TOPICS:

Structural, geotechnical and civil engineers have significantly contributed towards the protection and conservation of the natural environment especially when we consider the impact of natural disasters, like earthquakes, tsunamis and landslides, on infrastructures and the environment. Today, the emphasis of sustainability is on how to deal with the issues of limited resources and how to reduce the impacts on the natural environment. Research on the safety and stability of infrastructures against environmental impacts leads to the reduction of construction waste and disaster-caused debris waste and savings on non-renewable natural resources and energy. Research Group 3 (RG3) of the JSPS Core University Program on Environmental Engineering addresses issues related to the safety and stability of infrastructures in Asian regions against environmental impacts especially earthquakes. Thus RG3, aside from finding clever solutions to safety, economy and serviceability, addresses also the issue of sustainability by mitigating the social and ecological impact. This can be done by understanding the impact of natural hazards to infrastructures, finding ways of improving the modeling, analysis and design, enhancing the performance and upgrading the construction of new structures and extending the lifespan of existing structures.

2. RESEARCH OUTCOMES

2.1 Overview

The relationship between infrastructures and the environment can be illustrated in Figure 1. The built environment, which includes infrastructures such as residential houses, high-rise buildings, long-span bridges, roads and expressways, and large civil structures like dams and reservoirs, provide for a livable atmosphere for all. However, the impact of these infrastructures on the natural environment should be a concern. The environmental impact of infrastructure development with respect to the depletion of our natural resources and energy and production of construction and demolition waste is staggering.

The natural environment, through natural disasters, in a way contributes to its deterioration. Natural disasters like earthquakes, tsunamis, floods, typhoons and volcanic eruptions spoil both the built and natural environment. Aside from causing numerous deaths and injuries to
people, natural disasters had caused the destruction of important infrastructures such as buildings, bridges and roads and devastation of nature which contributed to environmental degradation. The destruction of infrastructures caused wastage of resources and energy used in their construction. Reconstruction of these infrastructures contributes to further depletion of natural resources.

The Impact of the Environment on Infrastructures
- Disasters due to natural hazards (earthquakes, tsunamis, landslides, flashfloods, volcanic eruptions, typhoons)
- Destruction and collapse of infrastructures causing deaths and injuries
- Structural deterioration (steel corrosion, foundation settlement, etc.) due to severe environment

The Impact of Infrastructures on the Environment
- Construction and operation of infrastructures uses natural resources and energy
- Costly repairs and rehabilitation of damaged infrastructures use more resources and leads to wastage
- End-of-life effects of structures and debris of structures damaged by disasters cause disposal problems

Figure 1. A Framework on the Relationship between Infrastructures and the Environment
2.2 Basic research methodology

Natural disasters due to earthquakes, tsunamis, typhoons and volcanic eruptions spoil the built environment. The negative impact of infrastructures on the environment, on the other hand, aggravates especially when natural disasters occur. How do structural and geotechnical engineers contribute towards the reduction of these negative impacts in a region where natural hazards like earthquakes, tsunamis, typhoons, volcanoes and landslides are prevalent?

Research Group 3 (RG3) of the JSPS Core University Program on Environmental Engineering addresses issues related to the safety and stability of infrastructures in highly urbanized and densely populated regions against environmental impacts especially earthquakes. The group recognizes the interrelationship between the natural environment and the built environment. The natural environment through geotechnical and seismic hazards affects the safety and stability of various infrastructures such as buildings, bridges, slopes and reclaimed lands. The built environment, on the other hand, introduces negative impacts in the natural environment through the use, reuse, wastage and disposal of construction materials. Thus RG3, aside from finding clever solutions to safety, economy and serviceability, addresses also the issue of sustainability by mitigating the social and ecological impact. This can be done by understanding the impact of natural hazards to infrastructures, finding ways of improving the modeling, analysis and design, enhancing the performance and upgrading the construction of new structures and extending the lifespan of existing structures. These activities on safety and stability, in the end, leads to the savings of non-renewable natural resources and reduction of construction waste and disaster-caused debris waste, also an environmental problem.

2.3 Case studies

2.3.1 Photo Archives on impact of natural disasters

To increase awareness about the impact of natural disasters on built infrastructures and the impact of structural and geotechnical failures on the environment, a photo archive and slide show video presentation was developed (Figure 3). Original photos contributed by RG3 members and photos from the internet under the public domain were compiled to produce the photo-video presentation using a digital video editor software. Highlighted in the photo archive and video presentation are some important natural disasters like earthquakes, landslides, tsunamis and volcanic eruptions and their effects on built structures. Through these
photos, lessons on the cause of the damage or collapse of structures may be learned and corresponding response can be done to reduce the impact of natural hazards. The photo-video presentation may be used in public lectures on natural disaster awareness and education. The photo archives can be found in the *Proceedings of the Fifth Workshop on Safety and Stability of Infrastructures against Environmental Impacts* (2006).

2.3.2 **Impact of natural disasters on infrastructures**

This section will present short descriptions of the impact and damage caused by natural hazards such as earthquakes, landslides, liquefaction, flashfloods, etc. *RG3 members are invited to present an article on this theme.* Possible topics are:

(a) Seismic damage to bridges, buildings and lifelines  
(b) Geotechnical hazards – landslides, liquefaction  
(c) Other environmental impacts on structures – corrosion, etc.

Contributions of RG3 members made during a period from 2000 through 2006 are as follows:  
(a) Seismic damage to bridges, buildings and lifelines

- “Use of Swedish Cone Penetrometer in Assessing the Ground Condition and Seismic Risk of Critical Areas in the Philippines” by Alexis Acacio et al (UPD)  
- “Applications of Artificial Neural Networks in Seismic Performance Studies of Reinforced Concrete” by Andres W.C. Oreta (DLSU)  
- “Damping on Non-classically Damped Buildings by Regression Analysis” by Giovanni Enecio (Univ. of San Carlos)  
- “Mitigating through Retrofitting” by Romeo Estanero (DLSU)  
- Parametric Investigation on the Flexure and Shear Behavior of RC Column to Evaluate its Seismic Performance” by Bernardo Lejano (DLSU) and K. Kawashima (TIT)  
- “Seismic Design and Retrofit of Bridges” by Kazuhiko Kawashima (TIT)
• “Seismic Performace of Bridge Columns with Interlocking Ties” by Kazuhiko Kawashima et al (TIT)
• “Carbon Fiber Sheet Retrofit of RC Bridge Piers” by Kazuhiko Kawashima et al (TIT)
• “Seismic Response of a RC Arch Bridge” by Kazuhiko Kawashima and A. Mizoguchi (TIT)
• “Effect of Restrainers to Mitigate Pounding between Adjacent decks subjected to a Strong Ground Motion” by Gaku Shoji and K. Kawashima (TIT)
• “Damage of Transportation Facility in the 1999 Kocaeli and Duzce, Turkey Earthquake and the 1999 Chi-Chi, Taiwan Earthquake” by Gaku Shoji and K. Kawashima (TIT)
• “Column and Isolator Interaction in an isolated Bridge” by Kazuhiko Kawashima et al (TIT)
• “Effect of Rotational Deformations of a High Damping Rubber Bearing Resulting from Hysteretic Flexural Deformation of an RC Column” by Gaku Shoji and Kazuhiko Kawashima (TIT)
• “Performance of Neural Network Models in Predicting the Confined Concrete Strength and Strain of Circular Columns” by Andres Oreta (DLSU)
• “Health Monitoring of Bolted Joint Connections by Laser Doppler Vibrometry” by Giovanni Enecio (University of San Carlos)
• “The Natural ‘Heartbeat’ of 100 Buildings in Metro Manila” by Benito Pacheco (UPD)
• “Measurement of the Natural Periods of Bridges in Metro Manila” by William Tanco (UPLB), Benito Pacheco, Romeo Solis, Victor Pulmano and Salvador Reyes (UPD)
• “Seismic Response Control of Bridges by Variable Dampers” by K. Kawashima and A. Ruangrassamee (TIT)
• “Prediction of Deflection of RC Beams Strengthened with Carbon Fiber Fabric and Carbon Plate” by Alan Tan (UPD)
• “A Study on Damping Characteristics of Pier-Foundation-Soil System under Earthquake Excitation” by A. Nakajima, K. Kanamaru, I. Sakai and N. Tsumura (Utsunomiya University)
• “Simulation of the Shear-Flexure Behavioral Responses of the Piers of the Hanshin Expressway” by Bernard Lejano (TUP)
• “Mechanism of Damage to Taiwan Bridges Caused by the 1999 Ch-Chi Earthquake” by Kenji Kosa et al (Kyushu Institute of Technology)
• “Analysis of Response Modification Factor for Seismic design” by Gakuho Watanabe and Kazuhiko Kawashima (TIT)
• Structural Damage Detection for Bolted Connection between Two Steel Plates Using Laser Doppler Vibrometry by Giovanni J. Enecio and M. Abe
• Experimental Study on Natural Vibration and Damping Characteristics of Simple Bridge Model and Its Numerical Evaluation by Akinori Nakashima, Naohiro Uchikawa and Isao Saiki
• Experimental Studies on Footing to Evaluate Ultimate Behavior against Earthquake by Kenji Kosa, Takashi Ando, Masato Shirato and Kazuyuki Mizuta
• Research Plan by Delphi Technique to Survey Experts’ Judgment on Seismic Capacity of Selected Building Types in Metro Manila B. M. Pacheco, W. T. Tanco and D. C. Peckley
• A Technique to Identify Natural Frequencies and 3-D Mode Shapes of Existing Buildings : Reference-Based Stochastic Subspace Identification (SSI/Ref) by H. A. Magpantay, L. I. Villanueva, B. M. Pacheco, W. T. Tanco and A. W. C. Oreta,
• Seismic Performance of C-Bent Columns by Kazuhiko Kawashima, Gakuho Watanabe, Shunsuke Hatada and Ryo Hayakawa
• Seismic Response of Bridges and Other Transportation Facilities under Extreme Ground Motions by Kazuhiko Kawashima
• A Study on Modeling of an Existing Steel Arch Bridge Focusing on its Natural Vibration Characteristics by Akinori Nakajima
• Feature of the 2004 Niigataken-chuetsu Earthquake -Comparison with Other Damaging EQs- by Takumi Toshinawa
• Artificial Neural Networks: Some Applications in Structural & Earthquake Engineering by Andres W.C. Oreta
• Vibration Testing of Major Bridges in Metro Manila for Structural Integrity by William Tanco and Benito Pacheco
• Seismic Performance Assessment of R.C. Columns by Panitan Lukkunaprasit
• Historic Structure: Environmental Damage/Structural Modelling, and Integrated Optimal Topology Design: Strength, Safety & Stability by Benjapon Wethyavivorn
• Drillstring Mechanics in Directional Drilling and Project on Rock Cutting by Sanchai Mitaim and Emmanuel Detournay
• Research Topics on Hazard Management by Suttisak Soralump
• Effectiveness of Confinement on Strength and Ductility of Reinforced Concrete Bridge Piers by Sumieng Ongsupankul, Torkul Kanchanalai and Kazuhiro Kawashima
• The 26 December 2004 tsunami disaster in Thailand: experience & lessons learned by Pennung Warnitchai (AIT)
• Tsunami damage & arrival time in Sri Lanka due to the Sumatra earthquake of December 26, 2004 by Shusaku Inoue (TIT)
• Behavior of RC bridge pier subjected to moderate seismic load by Torkul Kanchanalai (KU)
• Fiber method evaluation of the strength capacity of RC columns subjected to bi-axial bending by Bernard Lejano (DLSU)
• Effect of CFRP in confining circular RC columns using neural networks by Jason Maximino Ongpeng (DLSU)
• Effect of shear span ration on the fracture of deep beams by Kenji Kosa (Kyushu Inst. of Technology)
• Shear strengthening of RC beams using carbon fiber sheets & its resistance mechanism by Hideki Miyajima (Kyushu Inst. of Technology)
• A study on modeling of an existing steel arch bridge focusing on its natural vibration characteristics by Akinori Nakajima (Utsunomiya Univ.)
• Modeling of steel seismic semi-rigid connections with multilinear equation by Prakit Premtummakorn (Mahanakorn Univ. of Technology)

(b) Geotechnical hazards – landslides, liquefaction
• “Use of Swedish Cone Penetrometer in Assessing the Ground Condition and Seismic Risk of Critical Areas in the Philippines” by Alexis Acacio et al (UPD)
• “Liquefaction Risk Assessment of Metro Manila” by Jonathan Dungca (DLSU)
• “Ground Improvement and Materials Engineering for Ground Water Pollution Control and Soil Remediation” by Ezekiel Saguil (UPD)
• “Generalized Hyperbolic Stress-Strain Relationships for Nonlinear Deformation Analysis of Soils” by Mark Zarco (UPD)
• “Identification of Soil Parameters by Nonlinear Least Squares Method” by Mark Zarco (UPD)
• “Effects of Anisotropy of Sand on the Liquefaction Resistance Evaluated by Triaxial Tests” by Mitsutoshi Yoshimine (Tokyo Metropolitan University)
• “Lateral Resistance of Piles Subjected to Liquefaction-Induced Lateral Flow” by Akihiro Takahashi, Jiro Kuwano, Yasuyuki Arai, Atushi Yano (TIT) and Jonathan Dungca (DLSU)
• “The Natural ‘Heartbeat’ of 100 Buildings in Metro Manila” by Benito Pacheco (UPD)
• “Centrifuge Test on Seismic Stability of Reinforced Embankment” by J. Iawa, J. Kuwano and A. Takahashi (TIT)
• “Full-Scale Shaking Table Tests on the Behavior of Piles during Earthquakes” by Rolando Orense, et al. (University of Tokyo)
• “A Study on the Subgrade Reaction for the Buried Pipe Subjected to Ground Movement” by Naoaki Suemasa (Musashi Institute of Technology)
• “Case Records of Rock Slope Failures” by Hideki Ohta (TIT)
• “Behavior of Ariake Clay Deposits with Leaching During Earthquakes” by Hideo Nagase et al (Kyushu Institute of Technology)
• An Improved Implicit Integration Algorithm for the Sekiguchi-Ohta Constitutive Equation by Mark Albert H. Zarco, Hideki Ohta and Thirapong Pipatpongsa
• Parameter Determination Procedure in the Analysis of an Embankment Placed on Soft Clay Deposit by Hideki Ohta
• Experimental Studies on Footing to Evaluate Ultimate Behavior against Earthquake by Kenji Kosa, Takashi Ando, Masato Shirato and Kazuyuki Mizuta
• Research Plan by Delphi Technique to Survey Experts’ Judgment on Seismic Capacity of Selected Building Types in Metro Manila B. M. Pacheco, W. T. Tanzo and D. C. Peckley
• Site-Specific Evaluation of the Seismic Response Spectrum and Comparison with the New NSCP 2001
by B. M. Pacheco, M. H. Zarco, W. T. Tano and G. M. Pintor

- Shear Behavior of Sandy Soils under Monotonic and Cyclic Loading Conditions
  by Hirofumi Toyota and Kouichi Nakamura
- Pile-Soil Interaction in Lateral Flow of Liquefied Ground by Jiro Kuwano, Akihiro Takahashi, Yasuyuki Arai and Atsushi Yano
- Liquefaction Strength Characteristics of Overconsolidated Sand Samples under Ko Stress Condition by Hideo Nagase, Keisuke Shimizu, Akihiko Hirooka, Hiroshiige Maeda and Hiroki Ishihara
- Seismic Response Analysis under Multidirectional Shaking of Horizontally Layered Sites in Manila by Jaime Y. Hernandez Jr., Mark A. Zarco, and Richard Adrian Sison:
  - Proposed Liquefaction Assessment of Metro Manila using Effective Stress Method by Richard Adrian Sison and Mark A. Zarco:
- Behaviour of a Rockfill Dam during Construction
  by Hideki Ohta, H. Yoshikoshi, Y. Mori, S. Yonetani, M. Itoh and T. Ishiguro
- Centrifuge Shaking Table Tests on the Geogrid-reinforced Soil Wall Combined with Soil Cement by Jiro Kuwano
- Generalized Coulomb's Failure Criterion for 3-dimensional Stress Conditions by Mitsutoshi Yoshimine
- Failure mechanism of unsaturated cohesive soil by Hirofumi Toyota
- Effects of Underground Walls on Liquefaction-induced Subsidence of a River Dike in 1G and Centrifuge model tests by Tsuyoshi Honda, S. Fukui, A.M. Jahangir, I. Towhata and S. Tamate
- Drillstring Mechanics in Directional Drilling and Project on Rock Cutting by Sanchai Mitaim and Emmanuel Detournay
- Research Topics on Hazard Management by Suttisak Soralump
- Maximum shear stress generated by earthquakes for liquefaction analysis by Rolando Orense (Yamaguchi Univ.)
- Mitigation techniques of damages of quay walls due to seismic liquefaction by Tsuyoshi Honda (Tokyo Univ.)
- Centrifuge model tests on seismic stability of reinforced retaining wall by Satoshi Ichikawa (Musashi Inst. of Technology)
- Lateral resistance of pile in laterally spreading liquefied ground by Jiro Kuwano (Saitama Univ.)
- Embedment effect on the bearing capacity of spread footing in sand by Mary Ann Adajar (DLSU)
- Site geotechnical characterization based on single station microtremor data by Glen Pintor (UPD)
- A plasticity model for Swedish weight sounding test by Naoaki Suemasa (Musashi Inst. of Technology)
- Corner mode in the Sekiguchi-Ohta Model by Thirapong Pipatpongsa (TIT)
- Analysis of slope failure - July 2005 Bohol landslide by Mark Zarco (UPD)

(c) Other environmental impacts on structures – corrosion, etc.

- The 26 December 2004 tsunami disaster in Thailand: experience & lessons learned by Pennung Warnitchai (AIT)
- Tsunami damage & arrival time in Sri Lanka due to the Sumatra earthquake of December 26, 2004 by Shusaku Inoue (TIT)
- Public education of tsunami disaster mitigation & rehabilitation performed in Japanese primary schools by Hideki Ohta (TIT)
- Understanding Disasters & Development By Andres Oreta (DLSU)
2.3.3 Disaster mitigation technology

This section describes practical approaches and technology on mitigating the effects of natural hazards on infrastructures. *RG3 members are invited to contribute short articles describing the natural hazard and practical ways of mitigating its effects.* The tentative topics are:

(a) Bridges – Prof. Kawashima will describe most common types of damages in bridges due to earthquakes and the possible ways and technology of improving the seismic performance of bridges.
(b) Liquefaction – Prof. Kuwano will describe the effects of liquefaction on structures and practical approaches of soil improvement and design of foundations.
(c) Other contributions of RG3 members related to this theme – e.g. mitigating landslides

2.3.4 Application to the Southeast Asian Region

This section will present several case studies related to RG3’s theme as applied in the Southeast Asian region. *RG3 are invited to contribute short articles describing a specific issue/disaster/problem related to Southeast Asia and actions done.* The tentative topics are:

(a) The Asia Tsunami - Prof. Pennung will describe the impact and destruction of the Dec. 26, 2004 tsunami and lessons learned with respect to the design of structures.
(b) Public lectures for disaster awareness - Prof. Hideki Ohta will describe the public lectures on tsunami disaster awareness conducted in Indonesia, Thailand and Singapore.
(c) Philippine Leyte Landslide – Prof. Ohta and Dr. Mark Zarco will report the results of their postmortem analysis of the Leyte landslide 2006 and possible actions to prevent a similar disaster.
(d) Other case studies to be contributed by RG3 members.

3. GROUP ACTIVITIES

To address the issues of safety and stability of structures leading to sustainable civil engineering, RG3 conducted the following activities:

3.1 Exchange of researchers

Scientists from the Philippines and Thailand conducted researches in Japan through the *short term* and *long term* research visit under the program. The researches conducted by the Philippine and Thai visiting scientists through the JSPS Core University Program on Environmental Engineering can be categorized into three major themes and are shown in Table 1 (a), (b) and (c):
Table 1 Cooperative researches by exchange scientists in Group 3 in 2000-2005.

(a). Seismic damage to bridges, buildings and lifelines

<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>The Impact Echo Method : A Review</td>
<td>by Fernando J. Germar</td>
</tr>
<tr>
<td>1999</td>
<td>Role of Remote Sensing and Geographic Information Systems(GIS) in Organizing Responsive Researches and Extension Programs in Watershed/Coastal Sreas</td>
<td>by Renan Ma. T. Tanhueco</td>
</tr>
<tr>
<td>2000</td>
<td>Performance of Neural Network Models in Predicting the Confined Concrete Strenght and Strain of Circular Columns</td>
<td>by Andres W. C. Oreta</td>
</tr>
<tr>
<td>2000</td>
<td>Parametric Investigation on the Flexure and Shear Behavior of Reinforced Concrete Column to Evaluate Its Seismic Performance</td>
<td>by Bernardo A. Lejano</td>
</tr>
<tr>
<td>2001</td>
<td>Structural Damage Detecton for Bolted Connection between Two Steel Plates Using Laser Doppler Vibrometry</td>
<td>by Giovanni J. Enecio</td>
</tr>
<tr>
<td>2002</td>
<td>Seismic Retrofitting of Bridges</td>
<td>by Romeo A. Estanero</td>
</tr>
<tr>
<td>2002</td>
<td>Quantitative Non-Destructive testing and Evaluation Ultrasound Wave Propagation in Anisotropis Media</td>
<td>by Raymond Dimagiba</td>
</tr>
<tr>
<td>2003</td>
<td>Interaction of Carbon Fiber Reinforced Polymer and Lateral Steel Ties in Circular Concrete Columns as Confinement using Artificial Neural Network</td>
<td>by Jason Ongpeng</td>
</tr>
<tr>
<td>2003</td>
<td>Natural Vibration and Damping Characteristics of Steel Girder Bridge-Numerical Modeling Application</td>
<td>by Gerardo Apor</td>
</tr>
<tr>
<td>2005</td>
<td>Shear Strength of Reinforced Concrete Tied COLUMNS</td>
<td>by Tharin Kungsanant</td>
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</tbody>
</table>
### (b). Geotechnical hazards – landslides, liquefaction

<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Sekiguchi-Ohta Plasticity: Implicit Integration of Constitutive Equations Using a Nonlinear Elastic Stress Predictor</td>
<td>Mark Albert H. Zarco</td>
</tr>
<tr>
<td>2001</td>
<td>Soil-Pile Interaction in Liquefaction-Induced Lateral Spreading</td>
<td>Jonathna R. Dungca</td>
</tr>
<tr>
<td>2003</td>
<td>Use of Microtremors for the Evaluation of the Shallow Geologic Structure</td>
<td>Glenn Pintor</td>
</tr>
<tr>
<td>2004</td>
<td>Embedment Effect on the Bearing Capacity of Spread Footing in Sand</td>
<td>Mary Ann Adajar</td>
</tr>
<tr>
<td>2004</td>
<td>Behavior of square footing on sloping ground tested in centrifuge machine</td>
<td>Suttisak Soralump</td>
</tr>
<tr>
<td>2005</td>
<td>Surface Wave-based Ground Characterization for Seismic Site Response</td>
<td>William Tanco</td>
</tr>
</tbody>
</table>

### (c). Development and implementation of programs to mitigate the effects of natural hazards

<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>Impact of Natural Disasters on Infrastructures and the Environment: Designing for Safety and Stability leads to Sustainability</td>
<td>Andres Oreta</td>
</tr>
</tbody>
</table>
3.2 Workshops and Technical Tour

RG3 conducted “Workshops on Safety and Stability of Infrastructures against Environmental Impacts” as summarized in Table 2. These workshops were supported by JSPS. The objectives of these workshops were to identify the research needs and interests of Japan, the Philippines and Thailand in relation to the group’s theme. Proceedings of these workshops were published and submitted to JSPS and participating universities. The full papers for the first, second, third and fifth workshops are available in the Proceedings of “Workshops on Safety and Stability of Infrastructures against Environmental Impacts”. A CD of the powerpoint presentations in pdf format of the fourth workshop is available.

Table 2. Summary of RG3 Workshops on Safety and Stability of Infrastructures against Environmental Impacts

<table>
<thead>
<tr>
<th>Year</th>
<th>Topic</th>
<th>No of Participants</th>
<th>Papers</th>
<th>Venue</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>First Workshop</td>
<td>23</td>
<td>15</td>
<td>UPD</td>
</tr>
<tr>
<td>9.10-13</td>
<td>Second Workshop and Technical Tour</td>
<td>20</td>
<td>13</td>
<td>UPD</td>
</tr>
<tr>
<td>2002</td>
<td>Third Workshop and Technical Tour</td>
<td>20</td>
<td>15</td>
<td>UPD</td>
</tr>
<tr>
<td>11.11-13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>Fourth Workshop and Meeting</td>
<td>16</td>
<td>16</td>
<td>KU</td>
</tr>
<tr>
<td>11.25-27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>Fifth Workshop</td>
<td>23</td>
<td>20</td>
<td>DLSU</td>
</tr>
<tr>
<td>12.5-6</td>
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The details about the workshops including the titles of the papers presented in the workshops and the schedule are as follows:

**JSPS Core University Program on Environmental Engineering**

Research Group 3 Workshops on “Safety and Stability of Infrastructures against Environmental Impacts”

The Japan Society for the Promotion of Science (JSPS) Core University Program on Environmental Engineering aims to produce research focusing on the balance and harmony between the environment and infrastructure improvement needed for national and urban development. Under this program, Research Group (RG) 3 conducted workshops addressing the safety and stability of infrastructures against environmental impacts. Proceedings of these workshops were published and disseminated to JSPS, RG3 members, and participating universities. RG3 is divided into two subgroups with the following topics of research given emphasis:

I. Structural Dynamics and Earthquake Engineering

- Ambient vibration of built infrastructures (buildings, bridges, tunnels and other civil structures)
- Evaluation and modeling of nonlinear behavior of built infrastructures
II. Geotechnical Earthquake Engineering

- Liquefaction hazard evaluation using various methods
- Effect of liquefaction on stability of foundations
- Lateral capacity of foundation in low strength soils
- Stability of embankments and slopes

Highlights of the RG3 Workshops

1. **First Workshop**
   Date: November 20, 2000,
   Venue: University of the Philippines, National Center for Transportation Studies

   **Core Universities**
   - Tokyo Institute of Technology
   - University of the Philippines (Diliman / Los Banos)

   **Participating Universities**
   - De La Salle University
   - Technological University of the Philippines
   - University of San Carlos

   **Technical Program**
   **November 20, 2000**
   8:30 – 9:00 Registration
   9:00 - 9:10 Welcome Remarks – Victor Pulmano
   9:10 – 9:20 Opening Remarks – Kazuhiko Kawashima
   9:20 – 9:30 Introduction of the participants and guests – A. Oreta and K. Kawashima
   9:30 – 12:00 **Paper presentations** (Philippines)
     - “Use of Swedish Cone Penetrometer in Assessing the Ground Condition and Seismic Risk of Critical Areas in the Philippines” by Alexis Acacio et al (UPD)
     - “Liquefaction Risk Assessment of Metro Manila” by Jonathan Dungca (DLSU)
     - “Applications of Artificial Neural Networks in Seismic Performance Studies of Reinforced Concrete” by Andres W.C. Oreta (DLSU)
     - “Damping on Non-classically Damped Buildings by Regression Analysis” by Giovanni Enecio (Univ. of San Carlos)
     - “Mitigating through Retrofitting” by Romeo Estanero (DLSU)
     - “Parametric Investigation on the Flexure and Shear Behavior of RC Column to Evaluate its Seismic Performance” by Bernardo Lejano (DLSU) and K. Kawashima (TIT)
     - “Ground Improvement and Materials Engineering for Ground Water Pollution Control and Soil Remediation” by Ezekiel Saguil (UPD)
     - “Generalized Hyperbolic Stress-Strain Relationships for Nonlinear Deformation Analysis of Soils” by Mark Zarco (UPD)
   12:00 – 13:00 Lunch
   13:00 – 16:00 **Paper presentations** (Japan)
     - “Seismic Design and Retrofit of Bridges” by Kazuhiko Kawashima (TIT)
     - “Seismic Performance of Bridge Columns with Interlocking Ties” by Kazuhiko Kawashima et al (TIT)
     - “Carbon Fiber Sheet Retrofit of RC Bridge Piers” by Kazuhiko Kawashima et al (TIT)
     - “Seismic Response of a RC Arch Bridge” by Kazuhiko Kawashima and A. Mizoguchi (TIT)
“Effect of Restrainers to Mitigate Pounding between Adjacent decks subjected to a Strong Ground Motion” by Gaku Shoji and K. Kawashima (TIT)
“Damage of Transportation Facility in the 1999 Kocaeli and Duzce, Turkey Earthquake and the 1999 Chi-Chi, Taiwan Earthquake” by Gaki Shoji and K. Kawashima (TIT)
“Column and Isolator Interaction in an Isolated Bridge” by Kazuhiko Kawashima et al (TIT)

First Workshop Organizing Committee:
Over-all Coordinators: K. Kawashima (TIT) & A. Oreta (DLSU)
Members: M. Zarco (UPD), V. Pulmano (UPD) and B. Lejano (TUP)

2. Second Workshop and Technical Tour
Date: September 10-13, 2001
Venue: University of the Philippines, National Engineering Center

Core Universities
- Tokyo Institute of Technology
- University of the Philippines (Diliman / Los Banos)

Participating Universities
- De La Salle University
- Kyushu Institute of Technology
- Musashi Institute of Technology
- Technological University of the Philippines
- Tokyo Metropolitan University
- University of San Carlos
- University of Tokyo
- Utsunomiya University

Technical Program
September 10, 2001 (Monday)
8:30 – 9:00 Registration
9:00 - 9:10 Welcome Remarks
9:10 – 9:20 Objectives of the Workshop – Kazuhiko Kawashima
9:20 – 9:30 Introduction of the participants and guests – A. Oreta and K. Kawashima
9:30 – 10:30 Paper presentations – Bernard Lejano (Moderator )
  ▪ “Effect of Rotational Deformations of a High Damping Rubber Bearing Resulting from Hysteretic Flexural Deformation of an RC Column” by Gaku Shoji and Kazuhiko Kawashima (TIT)
  ▪ “Performance of Neural Network Models in Predicting the Confined Concrete Strength and Strain of Circular Columns” by Andres Oreta (DLSU)
  ▪ “Health Monitoring of Bolted Joint Connections by Laser Doppler Vibrometry” by Giovanni Enecio (University of San Carlos)
10:30 - 10:45 Break
10:45 – 12:00 Paper presentations – Jiro Kuwano (Moderator )
  ▪ “Identification of Soil Parameters by Nonlinear Least Squares Method” by Mark Zarco (UPD)
  ▪ “Effects of Anisotropy of Sand on the Liquefaction Resistance Evaluated by Triaxial Tests” by Mitsutoshi Yoshimine (Tokyo Metropolitan University)
  ▪ “Lateral Resistance of Piles Subjected to Liquefaction-Induced Lateral Flow” by Akihiro Takahashi, Jiro Kuwano, Yasuyuki Arai, Atsushi Yano (TIT) and Jonathan Dungca (DLSU)
12:00 – 13:20 Lunch
  ▪ “The Natural 'Heartbeat' of 100 Buildings in Metro Manila” by Benito Pacheco (UPD)
  ▪ “Measurement of the Natural Periods of Bridges in Metro Manila” by William Tanzo (UPLB), Benito Pacheco, Romeo Solis, Victor Pulmano and Salvador Reyes (UPD)
  ▪ “Seismic Response Control of Bridges by Variable Dampers” by K. Kawashima and A. Ruangrassamee
“Prediction of Deflection of RC Beams Strengthened with Carbon Fiber Fabric and Carbon Plate” by Alan Tan (UPD)

15:10 – 15:30 Break

15:30 – 16:30 **Paper Presentations** – Hideki Ohta (Moderator)

- “Centrifuge Test on Seismic Stability of Reinforced Embankment” by J. Izawa, J. Kuwano and A. Takahashi (TIT)
- “Full-Scale Shaking Table Tests on the Behavior of Piles during Earthquakes” by Rolando Orense, et al. (University of Tokyo)
- “A Study on the Subgrade Reaction for the Buried Pipe Subjected to Ground Movement” by Naoaki Suemasa (Musashi Institute of Technology)

16:30 – 17:00 Open Forum of RG3 Members

18:00 Dinner at Kamay-Kainan, Kalayaan Ave., Quezon City

### September 11, 2001 (Tuesday)

**9:00 – 10:15 Paper presentations** – Mark Zarco (Moderator)

- “A Study on Damping Characteristics of Pier-Foundation-Soil System under Earthquake Excitation” by A. Nakajima, K. Kanamaru, I. Sakai and N. Tsumura (Utsunomiya University)
- “Simulation of the Shear-Flexure Behavioral Responses of the Piers of the Hanshin Expressway” by Bernard Lejano
- “Mechanism of Damage to Taiwan Bridges Caused by the 1999 Ch-Chi Earthquake” by Kenji Kosa et al (Kyushu Institute of Technology)

10:15-10:30 Break

10:30 – 11:20 **Paper Presentations** – Gaku Shoji (Moderator)

- “Case Records of Rock Slope Failures” by Hideki Ohta (TIT)
- “Analysis of Response Modification Factor for Seismic design” by Gakuho Watanabe and Kazuhiko Kawashima (TIT)
- “Behavior of Ariake Clay Deposits with Leaching During Earthquakes” by Hideo Nagase et al (Kyushu Institute of Technology)

11:20 – 12:00 **Technical Visit Briefing on “Bridge Retrofitting Projects in Metro Manila”** by Angel Lazaro III

12:00 – 12:10 Technical Tour Briefing – Schedule, Preparation and Sites by Alan Tan

12:10 – 13:30 Lunch

13:30 onwards Free time

### Technical Tour Schedule

**September 12, 2001 (Wednesday)**

- **8:00 – 8:30** Assembly at Hotel Rembrandt
- **8:30 – 12:00** Tour of Metro Manila Bridge Retrofitting Projects
- **12:00 – 13:30** Lunch
- **13:30 – 17:00** Trip to Subic
- **17:00** Check-in at Subic International Hotel
- **19:00** Dinner

**September 13, 2001 (Thursday)**

- **8:00 – 9:00** Briefing of Subic Projects by Pete Templo (UTI and UPD)
- **9:00 – onwards** Start of Technical Tour: Viaduct along Mangroove trail, Boton 1 Bridge, Binatician Bridge, Malawaan 2 Bridge, Kalalake Bridge, Blasted Rock Formations, Drainage Profiles and Unsuitable Sections
- **12:00 – 13:00** Lunch at Subic International Hotel
- **13:00 – 15:00** Site seeing: Mangroove trail and Museum
- **15:00 – 18:00** Return to Manila

### Second Workshop Organizing Committee:

**Over-all Coordinators:** K. Kawashima (TIT) & A. Oreta (DLSU)
**Technical Workshop Coordinator:** M. Zarco (UPD)
**Technical Tour Coordinator:** A. Tan (UPD)
Members: J. Kuwano (TIT), B. Lejano (TUP), A. Acacio (UPD), H. Ohta (TIT) and B. Pacheco (UPD)

3. **Third Workshop and Technical Tour**
   **Date:** November 11-13, 2002
   **Venue:** University of the Philippines, National Engineering Center

**Core Universities:**
- Tokyo Institute of Technology
- University of the Philippines (Diliman / Los Banos)

**Participating Universities**
- Ateneo de Naga University
- De La Salle University
- Kyushu Institute of Technology
- Meisei University
- Nagaoka Institute of Technology
- Technological University of the Philippines
- University of San Carlos
- Utsunomiya University

**Technical Program**
**November 11, 2002 (Monday)**

**Opening Program** – Andres Oreta (Moderator)
8:30 – 9:00  Registration
9:00 - 9:15  Welcome Remarks
9:15 – 9:30  Overview of JSPS RG3 Activities – Kazuhiko Kawashima (TIT)
9:30 – 9:40  Introduction of participants – A. Oreta and K. Kawashima
9:40 – 10:00 Break

10:00 – 12:00  **Paper Presentations** – Bernardo Lejano / Jiro Kuwano (Moderators)
- Structural Damage Detection for Bolted Connection between Two Steel Plates Using Laser Doppler Vibrometry by Giovanni J. Enecio and M. Abe
- Experimental Study on Natural Vibration and Damping Characteristics of Simple Bridge Model and Its Numerical Evaluation by Akinori Nakashima, Naohiro Uchikawa and Isao Saiki
- An Improved Implicit Integration Algorithm for the Sekiguchi-Ohta Constitutive Equation by Mark Albert H. Zarco, Hideki Ohta and Thirapong Pipatpong
- Parameter Determination Procedure in the Analysis of an Embankment Placed on Soft Clay Deposit by Hideki Ohta

12:00 – 13:30  Lunch

13:30 – 15:00  **Paper Presentations** – Victor Pulmano (Moderator)
- Experimental Studies on Footing to Evaluate Ultimate Behavior against Earthquake by Kenji Kosa, Takashi Ando, Masato Shirato and Kazuyuki Mizuta
- Research Plan by Delphi Technique to Survey Experts’ Judgment on Seismic Capacity of Selected Building Types in Metro Manila by B. M. Pacheco, W. T. Tanzo and D. C. Peckley
- A Technique to Identify Natural Frequencies and 3-D Mode Shapes of Existing Buildings : Reference-Based Stochastic Subspace Identification (SSI/Ref) by H. A. Magpantay, L. I. Villanueva, B. M. Pacheco, W. T. Tanzo and A. W. C. Oreta,

15:00 – 15:30  Break

15:30 – 17:00  **Paper Presentations** – Kenji Kosa (Moderator)
- Site-Specific Evaluation of the Seismic Response Spectrum and Comparison with the New NSCP 2001 by B. M. Pacheco, M. H. Zarco, W. T. Tanzo and G. M. Pintor
- Shear Behavior of Sandy Soils under Monotonic and Cyclic Loading Conditions by Hirofumi Toyota and Kouichi Nakamura
- Seismic Performance of C-Bent Columns by Kazuhiko Kawashima, Gakuho Watanabe, Shunsuke Hatada and Ryo Hayakawa
November 12, 2002 (Tuesday)
9:00 – 10:00 Paper Presentations – Mark Zarco (Moderator)
- Pile-Soil Interaction in Lateral Flow of Liquefied Ground by Jiro Kuwano, Akihiro Takahashi, Yasuyuki Arai and Atsushi Yano
- Liquefaction Strength Characteristics of Overconsolidated Sand Samples under Ko Stress Condition by Hideo Nagase, Keisuke Shimizu, Akihiko Hiro-oka, Hiroshige Maeda and Hiroki Ishihara

10:00-10:20 Break

10:20 – 11:50 Paper Presentations – Hideki Ohta (Moderator)
- Seismic Response Analysis under Multidirectional Shaking of Horizontally Layered Sites in Manila by Jaime Y. Hernandez Jr., Mark A. Zarco, and Richard Adrian Sison
- Proposed Liquefaction Assessment of Metro Manila using Effective Stress Method by Richard Adrian Sison and Mark A. Zarco
- Application of Microtremors to Site Condition Estimates by Takumi Toshinawa

11:50 – 12:00 Technical Tour Briefing – Glen Pintor (UPLB)
12:00 – 12:30 Planning Workshop & Meeting – K. Kawashima & A. Oreta
12:30 – 14:00 Lunch

Technical Tour Schedule
November 13, 2002 (Wednesday)
7:00 – 7:30 Assembly at UPD and Sulo Hotel
7:30 Departure from Sulo Hotel
7:30 – 9:30 Trip to UPLB
9:30 – 10:30 Orientation at the UPLB Dept. of Civil Engineering
10:30 – 12:00 Site visit at IRRI
12:00 – 13:30 Lunch
13:30 – 15:00 Site visit at FPRDI
15:00 – 17:00 Return to Manila

Third Workshop Organizing Committee:
Over-all Coordinators: K. Kawashima (TIT) & A. Oreta (DLSU)
Technical Workshop Coordinator: M. Zarco (UPD)
Technical Tour Coordinator: G. Pintor (UPLB)
Members: J. Kuwano (TIT), B. Lejano (TUP), H. Ohta (TIT), V. Pulmano (UPD) and W. Tanzo (UPLB)

4. Fourth Workshop and Meeting
Date: November 25-27, 2004
Venue: Kasetsart University, Bangkok, Thailand

Core Universities: TIT, UPD, KU
Participating Universities: UPLB, DLSU, Kyushu Institute of Technology, Utsunomiya University, Nagaoka University of Technology, Meisei University, University of Tokyo, AIT, Chulalongkorn University, Tokyo Metropolitan University

Paper Presentations:
- Behaviour of a Rockfill Dam during Construction by Hideki Ohta, H. Yoshikoshi, Y. Mori, S. Yonetani, M. Itoh and T. Ishiguro
- Centrifuge Shaking Table Tests on the Geogrid-reinforced Soil Wall Combined with Soil Cement by Jiro Kuwano
- Generalized Coulom's Failure Criterion for 3-dimensional Stress Conditions by Mitsutoshi Yoshimine
• Failure mechanism of unsaturated cohesive soil by Hirofumi Toyota
• Effects of Underground Walls on Liquefaction-induced Subsidence of a River Dike in 1G and Centrifuge model tests by Tsuyoshi Honda, S. Fukui, A.M. Jahangir, I. Towhata and S. Tamate
• Seismic Response of Bridges and Other Transportation Facilities under Extreme Ground Motions by Kazuhiko Kawashima
• A Study on Modeling of an Existing Steel Arch Bridge Focusing on its Natural Vibration Characteristics by Akinori Nakajima
• Feature of the 2004 Niigataken-chuetsu Earthquake -Comparison with Other Damaging EQs- by Takumi Toshinawa
• Artificial Neural Networks: Some Applications in Structural & Earthquake Engineering by Andres W.C. Oreta
• Vibration Testing of Major Bridges in Metro Manila for Structural Integrity by- William Tanco and Benito Pacheco
• Seismic Performance Assessment of R.C. Columns by Panitan Lukkunaprasit
• Presentation on the Research by Pennung Warnitchai
• Historic Structure: Environmental Damage/Structural Modelling, and Integrated Optimal Topology Design: Strength, Safety & Stability by- Benjapon Wethyavivorn
• Drillstring Mechanics in Directional Drilling and Project on Rock Cutting by Sanchai Mitaim and Emmanuel Detournay
• Research Topics on Hazard Management by Suttisak Soralump
• Effectiveness of Confinement on Strength and Ductility of Reinforced Concrete Bridge Piers by Sumieng Ongsupankul, Torkul Kanchanalai and Kazuhiko Kawashima

5. Fifth Workshop
Date: Dec. 5-6, 2005
Venue: De La Salle University (Ortigas Seminar Room, DLSU Library)

Core Universities
- Tokyo Institute of Technology
- University of the Philippines
- Kasetsart University

Participating Universities
- Asian Institute of Technology
- De La Salle University
- Kyushu Institute of Technology
- Mahanakorn University of Technology
- Musashi Institute of Technology
- Saitama University
- University of Tokyo
- Utsunomiya University
- Yamaguchi University

Technical Program
December 5, 2005 (Monday)

Opening Program – Andres Oreta (Moderator)
8:50 – 9:00  Registration
9:00 - 9:15  Welcome Remarks – Pag-asa Gaspillo (Dean, DLSU COE)
Message - Julius Maridable (DLSU, VPAR)
9:15 – 9:30  Remarks about the Workshop – Hideki Ohta (RG3 Chairman)
Short messages & Introduction of Participants by RG3 Coordinators:
9:30 – 9:40  **Slideshow Presentation:**  
*Understanding Disasters & Development* By Andres Oreta (DLSU)

9:40 – 10:40  **Technical Session 1** – Hideki Ohta (Moderator)
- The 26 December 2004 tsunami disaster in Thailand: experience & lessons learned  
  by Pennung Warnitchai (AIT)
- Tsunami damage & arrival time in Sri Lanka due to the Sumatra earthquake of December 26, 2004  
  by Shusaku Inoue (TIT)
- Maximum shear stress generated by earthquakes for liquefaction analysis  
  by Rolando Orense (Yamaguchi Univ.)

10:40 – 11:40  **Technical Session 2** – Rolando Orense (Moderator)
- Mitigation techniques of damages of quay walls due to seismic liquefaction  
  by Tsuyoshi Honda (Tokyo Univ.)
- Centrifuge model tests on seismic stability of reinforced retaining wall  
  by Satoshi Ichikawa (Musashi Inst. of Technology)
- Lateral resistance of pile in laterally spreading liquefied ground  
  by Jiro Kuwano (Saitama Univ.)

11:40 – 13:00  **Lunch / Visit to the DLSU Museum**

13:00 – 14:00  **Technical Session 3** – Warakorn Mairaing (Moderator)
- Behavior of RC bridge pier subjected to moderate seismic load  
  by Torkul Kanchanalai (KU)
- Fiber method evaluation of the strength capacity of RC columns subjected to bi-axial bending  
  by Bernard Lejano (DLSU)
- Effect of CFRP in confining circular RC columns using neural networks  
  by Jason Maximino Ongpeng (DLSU)

14:00 – 15:00  **Technical Session 4** – Bernard Lejano (Moderator)
- Embedment effect on the bearing capacity of spread footing in sand  
  by Mary Ann Adajar (DLSU)
- Effect of shear span ration on the fracture of deep beams  
  by Kenji Kosa (Kyushu Inst. of Technology)
- Shear strengthening of RC beams using carbon fiber sheets & its resistance mechanism  
  by Hideki Miyajima (Kyushu Inst. of Technology)

15:00 – 15:40  **Break**

15:40 – 16:40  **Technical Session 5** – Mark Zarco (Moderator)
- Site geotechnical characterization based on single station microtremor data  
  by Glen Pintor (UPD)
- A plasticity model for Swedish weight sounding test  
  by Naoki Suemasa (Musashi Inst. of Technology)
- Corner mode in the Sekiguchi-Ohta Model by Thirapong Pipatponsa (TIT)

16:40 – 17:00  Presentation about JSPS by Toshiomi Yoshida (JSPS)

**December 6, 2005 (Tuesday)**

9:00 – 10:00  **Technical Session 6** – Torkul Kanchanalai (Moderator)
- A study on modeling of an existing steel arch bridge focusing on its natural vibration characteristics  
  by Akinori Nakajima (Utsunomiya Univ.)
- Paper presentation on disaster due to landslides  
  by Warakorn Mairaing (KU)
- Modeling of steel seismic semi-rigid connections with multilinear equation  
  by Prakit Prentummakorn (Mahanakorn Univ. of Technology)
10:00 – 11:00  **Technical Session 7**– Jiro Kuwano (Moderator)
  - Analysis of slope failure - July 2005 Bohol landslide by Mark Zarco (UPD)
  - Public education of tsunami disaster mitigation& rehabilitation performed in Japanese primary schools by Hideki Ohta (TIT)
11:00  Remarks by Prof. Kawamura (JSPS/Tohoku Univ.)

**RG3 Steering Committee**

**Coordinators:**
Hideki Ohta (Japan), Andres Oreta (Philippines), Torkul Kanchanalai (Thailand)

**Members:**
Jiro Kuwano, Mark Zarco, Warakorn Mairaing

**Workshop Local Organizing Committee (DLSU-Manila)**

Andres Oreta, Mary Ann Adajar, Jason Maximino Ongpeng, Bernard Lejano