STUDY REPORT

“JAPANESE EXPERIENCE”
ANALYSIS OF THE KNOW-HOW OF THE THIRD COUNTRIES

10-16 February 2012

EC Education and Culture Leonardo da Vinci supports:

SISMILE: Increase Vocational Skills to Face Earthquake Risk Inside Of Building

## Attendance – Present

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<tr>
<th>Institute</th>
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<tr>
<td>Kandilli Observatory and Earthquake Research Institute (TR)</td>
<td>Assoc.Prof. Nurcan Meral Ozel (NMO), Seismologist (Ms)Seyhun Puskulcu (SP)</td>
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<td>Pera Fine Arts Vocational Training Institute (TR)</td>
<td>Emine Gozen (EG), Karolin Yesilkaya (KY), Ayşe Sevil Vergili (ASV)</td>
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<td>Yamaguchi University</td>
<td>Assoc.Prof. Hitomi Murakami (HM)</td>
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<td>Kyoto University</td>
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| NPO for Safety Life Management Institute, Housing and Disaster Mitigation in Kobe | Keizo Fujimoto (KF)  
Takahiro Hasegawa (TH) |
| Kobe University                                                           | Prof. Kazuyoshi Ohnishi (KO)                                             |
| Disaster Management Policy Division, Disaster Management & Planning Bureau Policy Planning & Administration Department, Hyogo Prefectural Government | Masahiko Murata (MM) |
| Hyogo Earthquake Engineering Research Center National Research Institute for Earth Sience and Disaster Prevention (NIED) (E-Defense) | Ken’ichi Abe (KA) |
| Hokkaido University, Division of Architectural and Structural Design, Urban Safety Design, Urban Disaster Protection Planning Laboratory (Sapporo) | Prof. Keishi Okada (KO) |
INTRODUCTION

One of the goals of the SISMILE project is to perform an analysis of the training preferences and national differences on applications and seismological resistancies of different countries. An e-learning program covering the indoor non-structural mitigation will also be developed in this project in the framework of European Quality Standards which the furniture workers and public could easily understand. This report study aims to clarify how Japan responded against the shaking and also non structural damage in the houses during an earthquake. As a committed in the project; a survey to Japan were carried out to understand the conditions of the the most earthquake prone country in the world in terms of non structural hazard mitigation. We aimed to understand the similar conditions to EU countries, educational needs, background, skills, work and the training expectations of the craftsmen regarding the indoor safety and level of the Japanese partner potential supports. This report aims to give a general view of the Japanese experience and their way of non-structural mitigation in the buildings and also points out the similarities as well as dissimilarities between EU countries and Japan based on the information provided by the reports. This report provides a comprehensive overview of the possible know-how transfer to SISMILE project from Japan experience.

The Earthquakes

An earthquake is a shaking of the ground. It occurs when large masses of rock suddenly change position. Earthquakes and tremors (small earthquakes) are occurring somewhere around the globe all the time. Some cause a little shaking and people barely know what’s going on. Other cause catastrophic damage. Earthquakes killed 1.8 million worldwide between 1900 and 2005. Hundreds of thousands have died in single events. No other natural events have caused as much destruction in human history and no other events occur with such suddenness and capriciousness. The only thing that ranks with them are catastrophic volcanic eruptions and tsunamis. The former occur with much less frequency and are easier to predict than earthquakes. The latter are generally caused by earthquakes. If anything the destructive power of earthquakes increases as time goes buy as the number of people living in earthquake-prone areas increase even as technology to help them improves. Earthquakes usually occur on faults, massive cracks or fractures that usually are located around places that tectonic plates meet. The hypocenter or focus is the center of the energy of an earthquake, or where the earthquake originates below the surface of the earth. The epicenter is point in the earth’s surface directly above the hypocenter.
According to Japanese mythology earthquakes are caused by the thrashing movement of namazu (giant catfish), who has the power to generate tremors on both land and sea. One way to prevent earthquakes, the Japanese believe, is to knock the fish on the head with a gourd. After a devastating earthquake in the 1850s many people in Japan put up pictures of a KO’d catfish on the doors of their house for protection. Balancing on several tectonic plates, Japan is one of the most earthquake-prone countries in the world, with more than 130,000 quakes logged in 2005. Evan Osnos wrote in The New Yorker, “To geologists, earthquakes are a constant in the planet’s eternal becoming. To the Japanese, they are simply a constant. In a given year, there can be hundreds, usually barely discernible micro-events. They rattle the pictures on the wall, the china on the table, but they rarely stop the conversation.” Even so according to Yomiuri Shimbun survey, 78 percent of Japanese worry about a major earthquake. [Source: Evan Osnos, The New Yorker, March 28, 2011].

Japan is riddled with faults and is located at the junction of four tectonic plates. In the last 75 years, the Japanese archipelago or areas immediately offshore have experienced five earthquakes measuring more than eight on the Richter scale; and 17 measuring more than seven on the Richter scale. It is unusual for a year to go by without three or four earthquakes measuring 6.0 or more. Japan accounts for about 20 percent of the earthquakes of magnitude 6 or greater on the Richter scale. Each day about 1,000 tremors that can be felt are produced in Japan. More than 130,000 quakes were logged in Japan in 2005. Each year nearly ten percent of the energy released in the world in earthquakes is centered around Japan. In the last century Japan has experienced 25 destructive earthquakes. In some places small earthquakes are felt on a weekly and even daily basis. One journalist wrote that "Japan is always living on the edge of one disaster or another." The Japanese seismic scale is slightly different from the Richter scale used in the United States and elsewhere in the world. The Japanese scale has maximum intensity of 7 and measures earthquake based on the amount of damage caused. The destructive Kobe earthquake in 1995 measured 6.9 on the Richter scale and 7 on the Japanese scale. For an earthquake to be regarded as major enough to get a name it must destroy at least 100 houses, and measure more than 7 on the Richter scale or have an intensity of more than 5 on the Japanese scale.

Figure 1
Japan’s tectonic setting is a very active one, with hazard driven primarily by convergent plate boundaries (i.e., subduction zones and the related deformation). As shown in Figure 2, the Japanese Islands span the boundary between the Eurasian Plate and the Okhotsk Plate, and are bounded to the east by the Pacific Plate, and to the south by the Philippine Sea Plate. Three major subduction-related boundaries, marked by deep oceanic trenches or troughs, define the tectonics of the region: the Sagami Trough at the interface of the Philippine Sea and Okhotsk Plates; the Nankai Trough between the Philippine Sea Plate and the Eurasian Plate; and the Japan Trench between the Okhotsk and Pacific plates. A diffuse offshore boundary exists between the Eurasia and Okhotsk plates and along the northwest coast of Honshu. The three boundary zones along the eastern coast of Japan have high earthquake activity rates and have historically produced very large, damaging earthquakes (e.g., the 1944 Tonankai and 1946 Nankai events along the Nankai Trough; the 1923 Great Kanto Earthquake along the Sagami Trough).

Figure 2: Japan’s tectonic setting, illustrating the three subduction zones (Nankai Trough, Sagami Trough, and the Japan Trench) based on plate boundaries from Bird (2003); the rupture zone of the 2011 Tohoku event is shown along the Japan Trench.
The Philippine Sea, Pacific, and Okhotsk plates converge under the Tokyo metropolitan area, resulting in a uniquely complicated tectonic environment. The convergence of the three plates creates seismic activity within and between the plates (termed —intraslab| and —interface| events, respectively), with the Okhotsk Plate overriding the Philippine Sea Plate, and the Pacific Plate dipping beneath both. There is a concentration of deeper moderate magnitude events (M<7.5 at 15-100 km depth) in the region, referred to as Chokkagata (—directly beneath) events. Understanding the hazard posed by Chokkagata-type events is difficult due to the lack of clearly defined seismic structures. Researchers have attempted to define these complex structures, based on the microseismicity and seismic velocity in the region. For the Japanese National Seismic Hazard Maps, earthquake sources beneath Tokyo were defined by the Earthquake Research Committee (ERC) Headquarters for Earthquake Research Promotion (HERP) of Japan. It should be noted, however, that there are alternative and potentially equally valid interpretations of these data, such as the work by Toda and others (2008).

DAILY ACTIVITIES AND THE SURVEY

10.02.2012

The Japan study visit officially was started with visiting Disaster Prevention Division of Hokkaido prefectural government, in Sapporo. This division of the Prefectural government is responsible for guiding about 20 municipalities for disaster mitigation, especially earthquakes. In targeting earthquake preparedness and awareness promotion at household, community and business levels, indoor safety and prevention of casualty are important factors and they prepare some brochures. The project team obtained very detailed and productive information from the Hokkaido prefectural government on the content of SISMILE projects.

11.02.2012

The study group visited Hokkaido University, Division of Architectural and Structural Design Structural and Urban Safety Design Urban Disaster Protection Planning Laboratory Sapporo. This research laboratory has conducted a variety of advanced research studies related to disasters, involving undergraduate and graduate students. The center has maintained a particular focus on earthquake disasters since its establishment in 1973. Their interdisciplinary research includes a wide range of sciences including seismology, earthquake engineering, urban protection planning. This department have been greatly improving the seismic disaster assessment techniques in connection with earthquake mechanism theory, ground amplification theory and various kinds of vulnerability functions both from the seismological and earthquake engineering point of view. Prof. Okada has presented his own research about furniture vulnerability functions, indoor space microzoning, and casualty risk modeling and also provided a research paper to project members. We have concluded that the study of the indoor damage as a result of earthquake and risk of human casualty are the most suitable activities for SISMILE project.
The study visit was started with visiting E-Defense Laboratory (Hyogo Earthquake Engineering Research Center National Research Institute for Earth Science and Disaster Prevention) (NIED) and the representatives of Kandilli Observatory Institute and Pera Fine Arts met with Associate Executive Director of NIED, Dr. Eng. Kenichi Abe and his team and Executive Director of Nonprofit Organization Safety Living & Town Planning Organization Keizou Fujimoto together Associate Professor Hitomi Murakami from Yamaguchi University Division of Environmental Science and Eng. Graduate School of Science and Eng. and her team.

Figure 3: E-Defense laboratory and the meeting of Turkish and Japanese team

N. Ozel, S. Puskulcu, E. Gozen, A. S. Vergili and K. Basmaciyan as European team of the project was informed about the features of E-Defense Laboratory by Dr. Eng. Kenichi Abe. According to the his presentation, these information was gathered;

E-Defense Laboratory, of which long name is “3-D Full-Scale Earthquake Testing Facility”, is located in Miki Comprehensive Disaster Management Park and total construction cost of it is about 450 billion yen. The facility is considered as “the World’s largest and best performance shaking table” and it has max1200tons weight, covering 300 m² space.
After the 1995 Kobe earthquake (Hyogoken-Nanbu Earthquake), some lessons were learnt;
- Immediate need to evaluate existing structures and develop effective retrofit methods
- Motivation to improve seismic design for future construction

Every 100-150 year an earthquake occurs in strategic areas are Kobe, Kyoto, Nankai, Tonankai, Tokai and Tokyo in Japan. E-Defense can subject real-scale buildings and infrastructural systems to real earthquake conditions and is a tool for ultimate verification which has started to be developed since 1995. It was planned in 1995 and development & demonstration was done in 1998. Its construction has started in 2000 and it has started to function in 2005. It has included sections such as; Hydraulic Unit Building, Preparation Building, Experimental Building and Operation Building. Some tests were done with shaking table; for example, 31-year-old wooden actual houses were moved to E-Defense and one of them was kept in its original state while the other was reinforced with braces, etc. Both were shaken by a motion recorded during the 1995 Kobe Earthquake and as a result; the original one collapsed while the reinforced one saw little damage.

Figure 4: Different facilities of the E-Defense laboratory
The results indicate the effects of reinforcement. Another experiment was done in R/C school buildings, again with original and reinforced ones. Two 3-story school buildings were shaken separately. Original building lacked strength to resist the earthquake (Severe damages, unusable after the event) and another building which was reinforced by external steel braces verified the effects of reinforcing.

Also, some tests were done about bridge pier which was damaged in 1995 Hanshin – Awaji Earthquake and restoration of it required 623 days. The collapse of a pier was reproduced and was tested by shake more than the event. One pier was reproduced with the technology of ’70s and one was designed by up-dated technique and a new material and at the end of the tests, the verification of the updated technique was done.
Another issue was subjected in 1995 Kobe event/Thokai + Thonankai event related with hospitals and the evaluation was done through the seismic isolation by 4-story reinforced concrete hospital buildings (base isolated and base fixed versions). In base fixed case, the results were examined as; violent motion of heavy equipment, scattered items, littered environment seriously hinders medical activity and in base isolated case the results were recorded as; calm-environment in short-period ground motion and violent motion of wheeled equipment in long-period ground motion and at the end necessity of resolution were defined considering the most hospital equipment are mounted on wheels.

Room safety of High-Rise Buildings was subjected via testing long period ground motions. Prepared and non-prepared rooms’ cases were evaluated and retrofitting for high-rise buildings also was considered. Structural performance of high-rise buildings and benefit of retrofitting method (reinforcements for connections and dampers) were defined. After the presentation of Dr. Abe, the units of the E-Defense laboratory were visited by the delegation.
After the visit, the delegates moved to Disaster Management Policy Division Disaster Management & Planning Bureau Policy Planning & Administration Department Hyogo Prefectural Government in Kobe. The director of Disaster Management Policy Division, Mr. Masahiko Murata met with the delegates and presented their works as;

Japan’s land area is 0.25 % of the world but the occurrence frequency of earthquakes larger than magnitude 6+ is 20 % of the world. An earthquake of the Great Hanshin-Awaji Earthquake level was unprecedented. The Great East Japan Earthquake was beyond expectation (Then assumed intensity was M8.4 at the time, but the actual tremors were M9.0 followed by a gigantic tsunami and a nuclear power plant accident). The Great Hanshin-Awaji Earthquake which was in magnitude 7.3 (JMA) costs 9.9 trillion yen and caused 6,437 dead/missing.

Besides, he also gave information about establishment of advanced initial response system providing 24-hour monitoring and response service. The system was established in Hyogo Prefecture Dis. Man. Center and included Seismic Resistant Structure, Headquarters Control Room, Operation Room and Media Conference Room by organization of 20 senior staff and 50 first responders. The system has ability to collect information and disseminate it by 334 terminals set in municipal, government offices, police, hospitals, SDFs, etc. It collects information promptly and shares it with municipalities in Hyogo to speed up initial response by quick damage and needs estimation and disseminates emergency information to citizens via Hyogo Emergency Net. In renewal of regional disaster management plan, damage assessment of potential earthquake was done and the Tsunami Mitigation Center was opened in Awaji in 2010. It has a system which provides automatic closing of 37 flood gates by JMA alarm and works on public awareness & education for Tsunami preparedness. Also it works in system called TeLL-Net (international disaster transfer live lessons network) which provides possibility to transfer live lessons to the world, to the future. The Hyogo Prefectural Government tries not to forget January 17 and organizes it as Hyogo Safety Day and tries to share the experience and knowledge by some publications like “Hyogo’s one month record”, “Hyogo’s one year record”, “sharing lessons of the earthquake”, etc.

Mr. Maruta also gave information about the Great East Japan Earthquake held in March 11, 2011. The earthquake which caused damage from 16 to 25 trillion yen and 19,294 dead/missing realized in Magnitude Mw9.0. He informed the delegates about the details and results of this earthquake and challenges that came to light after the Great East Japan Earthquake. At the end, he presented E-Defense laboratory and experiments were done there especially related with the non-structural elements. He showed the videos of the experiments done in different type rooms furnished by different materials by different shakings. He shared the DVD and guide book for safe furniture setting which was done by the organizations. The DVD was watched together with the delegates and it was concluded that the DVD could be a good example for SISMILE project. It includes information on how we can protect ourselves from the moving or/and falling furniture during the earthquakes. The delegates took one example from the DVDs to transfer the good practices to the project.
Figure 9: “Furniture and contents move, fall, fly, and break” Learning material for highrise indoor safety against next major earthquake, by collaboration of Tokyo Metropolitan and 8 prefectural governments, 2011.

Then Prof. K. Ohnishi presented his research related with the non-structural elements inside the buildings. He informed the delegates what kind of furniture have caused injuries and/or damages inside the buildings in which level during the earthquakes and what kind of prevention activities must be done to mitigate the level of the damages or/injuries. The meeting was finished by the thanks of the both side.
The second day was started with the meeting in Kyoto University with Associate Professor Hitomi Murakami from Yamaguchi University and Dr. Eng. Maki Koyama from Kyoto University. Mrs. Murakami made a welcome speech and introduced Koyama to the delegates. Then Mrs. Ozel presented the project details and her presentation included the information about SISMILE project structure and recalled all the details regarding the project phase. She has stated all the work packages responsibilities based on a common understanding of the objectives. The roles of all of the partners have been reviewed in connections with the work packages. The presentation is dedicated to the overall objectives, structure, and organization of the project.

After her presentation, Mrs. Murakami explained the studies in Japan on furniture and indoor risk of earthquakes. The study was prepared by the collaboration of Mrs. Murakami and T. Nakashima and included information on field and questionnaire survey on furniture damage, damage function of furniture and interior damage; casualty related to architectural and contents damage and raising awareness and dissemination.

Then Mrs. Murakami did a presentation related with “indoor damages in large earthquakes” which was based on the researches of Division for Earthquake Disaster Prevention, Tokyo Fire Department. Via presentation these information was gathered;
- 16 major earthquakes (M>6) were realized in Japan between 1995 and 2011.

Figure 12: 16 major earthquakes (M>6) were realized in Japan between 1995 and 2011.

- Share of falling and moving furniture causing human causalities in recent earthquakes realized as;
  - 2008 Northern Miyagi 49.4 %
  - 2003 Off Tokachi coast 36.3 %
  - 2004 Chuetsu, Nigata pref. 41.2 %
  - 2005 Off west Fukuoka 36.0 %
  - 2007 Noto peninsula 29.4 %
  - 2007 Off Chuetsu, Niigata pref. 40.7 %
  - 2008 Iwate Miyagi inland 44.6 %

- Relation of JMA Intensity and Falling Furniture (Japan Meteorological Agency Intensity Table). In wider region, furniture fall, move and contents fall.
Figure 13: Relation of JMA Intensity and Falling Furniture (Japan Meteorological Agency Intensity Table). In wider region, furniture fall, move and contents fall.

- Intensity 5+ / Dishes, book shelves may fall
- Intensity 6 - / Many of heavy furniture without fixing move or fall
- Intensity 6+ / Heavy furniture without fixing move or fall
- Intensity 7 / Most furniture move and some jump or fly

- Damage Scenario of Earthquake in the Capital in 2006: Estimation of human casualties due to the Northern Tokyo Bay eq.
  - Furniture and building contents falling, moving 34.2 % and 54.500 ¥ (countermeasures for furniture fixing crucial)
  - Collapse of buildings 46.2 %
  - Outdoor objects, block walls falling 5.7 %
  - Eq. fire 9.6 %
  - Traffic damage 4.3 %

- Injury estimation by falling furniture and contents damage in Tokyo Metropolis is about 54.500 ¥ verifies the importance of the self-preparedness and pre earthquake actions for fixing furniture in households

- People learn importance of furniture countermeasures after a large earthquake experience;
  - Pre earthquake fixing rate in lower floors 4.1 %
  - Pre earthquake fixing rate in mid floors 9 %
  - Pre earthquake fixing rate in high rise floors 3.9 %
  - Post-earthquake fixing rate in lower floors 22.0 %
  - Post-earthquake fixing rate in mid floors 34.1 %
  - Post-earthquake fixing rate in high rise floors 35.1 %
- East Japan Earthquake Disaster (off the Pacific coast of Tohoku earthquake) dated 2011.03.11;
  - Extreme shaking in very large region (Max JMA Intensity, 7 in Kurihara city, Miyagi pref., intensity in Tokyo 5+, 20 cities, 11 towns, 1 village observed in Miyagi, Fukushima, Ibaragi, Tochigi pref.)
  - Long lasting shaking (170 seconds shaking over intensity 4 in Miyagino ward (intensity 6-), Sendai city 130 seconds shaking intensity 4 in Chiyoda ward (intensity 65+), Tokyo)
- Comparison of damages;
  - East Japan EQ disaster;
    - Date and Time: 2011.03.11 (Friday) and 14h46m
    - Magnitude: M9.0 depth 24 km
    - Dead: 16.131
    - Missing: 3.240
    - Injured: 5.994
    - Building damage: 1.046.089
    - Fire: 286
  - Hanshin Awaji EQ disaster;
    - Date and Time: 1995.01.17 (working day) and 5h6m (early morning)
    - Magnitude: M7.3 depth 16 km
    - Dead: 6.434
    - Missing: 3
    - Injured: 43.792
    - Building damage: 639.686
    - Fire: 269
- Questionnaires provide results of the survey in the East Japan EQ Disaster on furniture falling and moving in housing and offices in Tokyo Metro police (outline), which was undertaken from July 1st to 27th, 2011 within area of Tokyo Fire Department. Respondents of the survey were general households (with more than 2 people) who were 1206 and offices and business places were 1224 cases.

- Ratio of households with furniture falling or moving, including more than two pieces damaged in household;
Figure 14: Ratio of households with furniture falling or moving, including more than two pieces damaged in household

- No, there wasn’t 78%
- Yes, there was 22%
  - Microwave 9%
  - PC 9%
  - TV 30%
  - Bookshelf 31%
  - Wardrobe 14%
  - Refrigerator 10%
  - Cupboard 31%

- Ratio of furniture falling or moving in offices and job places;
  - No, there wasn’t 78%
  - No response 2%
  - Yes, there was 20%
  - Bookshelf 7%
  - Cabinet 6%
  - Cloth rocker 3%
  - Partition 5%
  - PC 5%
  - Copy machine 3%
  - Server luck 3%
  - TV 4%
• Refrigerator 1 %  
• Steel luck 6 %  
• Desk 3 %  
• Commodity shelf 14 %  

- Ratio of furniture falling or moving by floors in offices and job places:
  o Over 11th floors  
    • Fell 17.1 %  
    • Moved 13.3 %  
  o 6-10th floors  
    • Fell 26.9 %  
    • Moved 9.1 %  
  o 3-5th floors  
    • Fell 12.8 %  
    • Moved 5.8 %  
  o 1st or 2nd floors  
    • Fell 10.2 %  
    • Moved 4.6 %

- Ratio of copy machines falling or moving by floors in offices and job places (heavy machines with casters like copier move around on upper higher floors):
  o Over 11th floors  
    • Fell 2 %  
    • Moved 12 %  
  o 6-10th floors  
    • Fell 3 %  
    • Moved 3 %  
  o 3-5th floors  
    • Fell 2 %  
    • Moved 3 %  
  o 1st or 2nd floors  
    • Fell 1 %  
    • Moved 2 %

- Ratio of desks falling or moving by floors in offices and job places (desks regarded as not movable were found falling or moving):
  o Over 11th floors  
    • Fell 2 %  
    • Moved 4 %  
  o 6-10th floors  
    • Fell 5 %  
    • Moved 2 %  
  o 3-5th floors  
    • Fell 3 %  
    • Moved 2 %
1st or 2nd floors
• Fell 1%
• Moved 2%
- Ratio of furniture falling or moving by floor levels in general households;
  o Over 11th floors 47.2%
  o 6-10th floors 31.9%
  o 3-5th floors 23.8%
  o 1st or 2nd floors 16.8%
- Reasons why one did not take preparedness actions for furniture safety (pre eq.);
  o General Households
    • Furniture can be hurt, damage to walls
    • Not dangerous, to occupants. Not likely to fall
  o Offices and job places
    • Takes time, costs money
    • Not dangerous to occupants. Not likely to fall
- Furniture with fixing prior to the 311 earthquake;
  o General Households
    • Cupboard 499
    • Refrigerator 150
    • Wardrobe 454
    • Bookshelf 357
    • TV 277
    • PC 46
    • Microwave 54
    • Others 20
    • NA 2
  o Offices and job places
    • Bookshelf 46.3%
    • Cabinet 39.8%
    • Cloth rocker 30.0%
    • Partition 23.5%
    • PC 9.3%
    • Copy machine 10.2%
    • Server luck 36.2%
    • TV 24.1%
    • Refrigerator 7.1%
    • Steel luck 27.2%
    • Desk 6.7%
    • Commodity shelf 22.9%
- Earthquake disaster preparedness (pre 311 disaster)
  - Retrofit of housing 222
  - Participation to earthquake and evacuation drill 601
  - Store food & water for emergency 871
  - Store bath water 547
  - Check evacuation place 741
  - Else 52
  - Fixing furniture 711
  - NA 17

- Questionnaire survey for inland area of Miyagi and Fukushima prefecture;
  - Miyagi prefecture
    - Kurihara city (I-JMA 7) 96
    - Osaki city (I-JMA 6+) 1.092
  - Fukushima prefecture
    - Sukagawa city (I-JMA 6+) 36
    - Koriyama city (I-JMA 6 minus) 219

- Falling furniture in the Great East Japan earthquake;
  - Miyagi
    - No, there wasn’t 38 %
    - Yes, there was 61 %
  - Fukushima
    - No, there wasn’t 25 %
    - Yes, there was 75 %

- Actions to fix furniture prior to the Great East Japan earthquake disaster;
  - Miyagi
    - No, actions taken 46 %
    - Yes, actions taken 53 %
  - Fukushima
    - No, actions taken 77 %
    - Yes, actions taken 22 %

- Reasons not to fix furniture / age group comparison;
  - Miyagi
    - Furniture can be hurt, damage to walls
    - Not dangerous to occupants, not likely to fall
  - Fukushima
    - Furniture can be hurt, damage to walls
    - Not dangerous to occupants, not likely to fall

- Hearing survey for indoor damage of office buildings in Sendai city (49 cases) (Actions to fix furniture in offices / pre 311 earthquake disaster);
  - No, actions taken 45 %
  - Yes, actions taken 55 %
- What we learn from earthquake disasters on indoor safety;
  - Earthquake! First protect yourself! When you feel an earthquake or notice real time earthquake warning

- Importance of furniture fixing to prevent falling in earthquakes;
  - 30-50 % of injures are caused by falling furniture in recent earthquakes.
  - Actions to prevent furniture falling make a big step to protect yourself and your family
  - If you make pre-actions to prevent furniture falling, and not to get injured, you will help others and not to be helped
  - Furniture falling may cause fires. Fixing furniture reduce risk of fires.

- Points for fixing furniture;
  - Reduce items in a room (better to use storage and closet)
  - Pay attention to furniture layout (not to put vulnerable furniture in a bedroom, living room, near fire places)
  - Do not put bookshelves in corridor, as falling bookshelves disable evacuation (there is a case of wardrobe falling to make bathroom door locked)
  - Fix furniture if you need to settle in a room
  - Pay attention to moving furniture in addition to falling in high-rise apartments and offices.

- Target for disaster mitigation: Strategy for disaster mitigation for capital earthquake, Disaster Mitigation Plan for Tokyo Metropolitan Government (Raise rate of furniture fixing and indoor safety actions to 60 % by year 2015 (Heisei 27).
After the presentation of Mrs. Murakami, Mrs. Koyama shared her researches related with the “development of active evacuation system through computer vision technology” with the delegates. She informed that they have been realizing this search with Shigeyuki Okada from Hokkaido University and Tadayoshi Nakashima from TRIES. During her presentation, these information was gathered;

- Major weapon under an earthquake
  - Hyotoken Nanbu Earthquake / 1995
    - Unknown 3 %
    - Collapse of house 3 %
    - Others 18 %
    - Furniture 46 %
    - Broken Glasses and Dishes 29 %
  - Miyagiken Hokubu Earthquake / 2003
    - Boiling water 3 %
    - Falling down 24 %
    - Others 11 %
    - Furniture 49 %
    - Broken Glasses and Dishes 15 %
  - Nigataken Chuetsu Earthquake / 2004
    - Boiling water 11 %
    - Falling down 25 %
    - Others 16 %
    - Furniture 41 %
    - Broken Glasses and Dishes 8
Major weapon under an earthquake

- Furniture is a major weapon under an earthquake

![Diagram showing major weapons under earthquake](image)

**Figure 15:** Major weapon under an earthquake

- Ratio of secure furniture (The cabinet office, government of Japan -2005):
  - Secure 20.8%
  - Non-secure 79.2%
- The injury risk rate could be calculated as: Furniture fasten ratio = number of fasten furniture / number of furniture = 44%
- Measures for safety during an earthquake:
  - Before:
    - Furniture fastening
    - Safety disposition of furniture
  - During an earthquake:
    - Moving for safe area
    - Indication of high risk area
    - Early warning
  - After:
    - Evacuation
- Development of Active Education System through Computer Vision Technology:
  - The first prototype system using web camera (2008);
Figure 16: The first prototype system using web camera

Web camera (video capture) → Background image → Capture image (person contour) → Background subtraction using frame difference
Toppling area (Red: High risk area, Orange: Moderate risk area)
Indication of injury risk by toppled furniture;
Small furniture > sight injury
Heavy furniture > heavy injury

- The second prototype system using infrared camera;

Figure 17: The second prototype system

- Application for night time using infrared camera
- System safety
- Applicable multiple people
Optical image → Thermographic image → Risk assessment → Human extraction (the case of 6 upper JMA scale)
- Future subject
  - Navigate safe space by a robot
  - Development smartphone based injury risk assessment system

![Figure 18: Furniture in housing unit and estimate of risk mapping with and without securing actions. Real time monitoring of occupant movement and warning message system development (after Koyama et al.)](image)

After the presentation of Mrs. Koyama, Mrs. Murakami started to give information about the studies of K. Meguro, D. Ito and Y. Sato about “efficiency of furniture overturning protection devices during earthquakes – an experimental and numerical study” which was presented in the 14th World Conference on Earthquake Engineering in 2008. Within this presentation, following information was gathered; After the Kobe Earthquake, strengthening houses and attachment of furniture to prevent its overturning were identified as the main issues. Reportedly, these problems have not been properly addressed yet. One of the principal causes for this is that many people do not have disaster prevention consciousness and ability to prepare against earthquakes. In their study, the aim is at improving the people’s capacity to imagine disasters so that they implement specific disaster countermeasures. At first, they analyzed the effect of furniture overturning prevention devices and evaluate its efficiency through shaking table tests. The effectiveness of the devices is discussed based on the ground motion intensity which they can withstand, their installation easiness, whether their performance depends on external factors such as wall and floor characteristics, and so on. Then, they tried to promote people’s danger and risk awareness by showing animations obtained by numerical simulations of furniture’s dynamic behavior when an earthquake occurs, especially focusing on a particular house space, the living room. For this purpose, advanced visualization software is used so that people can feel as if they were at their own rooms during a shake. Finally, they promoted people’s recognition of disaster countermeasures by discussing the furniture overturning ratio decline when prevention devices are installed.

In the first part of this study, shaking table tests to evaluate the efficiency of existing overturning protection devices were performed with solid wooden blocks and furniture. After the last series of
tests, the best way to install the overturning protection devices available in the market was proposed.

To evaluate the safety of the living space, 3D-EDEM numerical simulations combined with virtual reality applications were carried out. The accuracy of the simulations was verified with the obtained experimental data. Based upon the results for a 20-story building case, it was concluded that it was very difficult to avoid overturning using protection devices currently available in the market for shakes JMAI 7+ and 7++, which are experienced in the upper stories. Therefore, three possible solutions were suggested: to decrease the structural response using building vibration control systems, to use more efficient overturning prevention systems, or to use only built-in type of storing spaces so that potential overturning objects are not used at all. The present study can be very useful to further study these options.”

Mrs. Murakami continued to share knowledge by presenting the study called “Damages, Human Behaviour and Recovery Process of Condominium Residents in the 2005 West off Fukuoka Earthquake” which was done by the collaboration of H. Murakami (Yamaguchi University), A. Kawano (Kyushu University) and K. Sakino (Kyushu University). The following information was gathered by this presentation; “The 2005 west off Fukuoka earthquake occurred on March 20, Sunday at 10h53m in the morning. The JMA magnitude was 7.0 and the epicenter was located at 33 deg. 44.35 min. N in Longitude and 130 deg. 10.58 min. Human casualty in this earthquake is 1 human loss by collapse of concrete block wall, 75 serious injuries, and 994 light injuries as reported by Fukuoka prefectural government. In Fukuoka city with 1.4 million populations, damages in Central ward were serious for mid-rise condominium buildings. Many condominiums suffered non-structural damages with infill walls cracked, and they often disabled opening of doors and evacuation routes. The authors made a questionnaire survey to the residents of several condominium buildings to elucidate relations of indoor architectural damage, occupants’ behavior, evacuation, and risk of casualty. We also made a hearing survey for the relief and recovery process of damaged condominiums.

They made questionnaires survey for the 8 condominium buildings with 364 households to ask architectural and indoor damage and human behavior of the occupants. The questionnaire asks indoor architectural damage conditions, human response during and after the earthquake, location of family members and casualty, evacuation behavior, preparedness before and after the earthquake. Total number of family members and occupants listed in the questionnaire is 339 persons. As for architectural damage, difficulty or unable to open the doors is 9 %. As for the wall damage, 18 % answer fallen and displaced walls. Some occupants had to evacuate thru balcony partition to their neighboring dwelling units.
Figure 19: Damage frequency of entrance doors (left) and walls of residential units

As for the interior contents damage, rates of falling in 10-14th floors are 2 to 4 times higher than those in 1-3rd floors as reasonably explained by higher floor response in upper floors. Falling rates are highest for bookshelf and TV, and are medium for wardrobe and cupboard. Damages are severest for living room and kitchens followed by bedrooms.

Figure 20: Furniture falling rates vs. floor levels (left) and injury distribution of 339 respondents (family members) (right)

By observing 196 cases, it is defined that the falling rate of the furniture is coming higher in upper floors and besides the falling rate is highest in bookshelf and TV and wardrobe are following this furniture.

As for the earthquake preparedness at home, 2 % answered that they had taken measures to prevent falling furniture before the earthquake, which seem to be much lower than other survey results in Tokyo metropolitan area and other regions, reflecting Fukuoka citizens’ belief that Fukuoka would be free from any damaging earthquakes. After the earthquake, 52 % answered that they took measures for indoor safety to prevent falling furniture and objects. It is important to disseminate earthquake safety measures to raise awareness and preparedness of people, because potential earthquake hazard by future occurrence of Kego fault earthquake is significantly high.
Also it is asked to the households that they had asked earthquake safety and structural conditions of the condominium building when they made decisions to purchase or to rent the dwelling unit. Majority of 73% say they didn’t make any injury, and 21% say that they asked few questions. It is important for lay people to ask for due explanation of earthquake safety, ground conditions, structural safety levels and expected level of damages in case of a major earthquake.”

Then Mrs. Murakami gave information to the delegates about a documents’ (sources) list related to non-structural elements prevention, indoor damage and causalities in Japan.

After the presentations, the delegates discussed some details related with the tasks of Japan partner and project implementation.
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Discussion (chair by H. Murakami)
(a) 2nd and 3rd All members meeting
After the presentations, the delegates discussed some details related with the tasks of Japan partner and project implementation. Within the project, it was written that the third country partner will share knowledge and good practices in the second partnership meeting which is going to be held in Athens in 3-4 April 2012 but the partner explained that it is too early for transferring adequate know-how to the project because they need to time to finish the research and suggested to extend the time for preparation. P1 thought that it is suitable to the project structure; this knowledge could be more useful during development of the training programme, so it was decided that Japan partner will share its know-how in the third partnership meeting which is going to be held in Bulgaria in July, 2012. Besides, the applicant (KOERI) requested from Japan partner to give information which was shared during the meeting as written and to supply the presentations, visual and textual materials to them and Mrs. Murakami promised to do it as soon as possible.

(b) Target group of the WBT system development
Indoor space characteristics, space, contents, size, density, occupants (human behavior)
Applicability of Japanese studies to EC environment
Tasks and schedule, Information to be collected

(c) Expected report from Japanese counterpart
- Learning material for earthquake indoor safety
- Curriculum, syllabus for learning in vocational schools, furniture makers, and interior design courses, etc.
- Guidelines for earthquake indoor safety in offices, housings, hospitals, schools, and so forth, if any is existing and available.
- List of important references in research and classification of studies
- Translation of abstracts from Japanese to English

(d) Importance of publication efforts
As outcome of SISMILE project, members agree to make effort to publish co-authoring papers in some international conferences.
As researchers in academic field, publication of papers is important. Realizing the WBT system effective for training and learning indoor and furniture safety in earthquakes are primary responsibility for the project members, however, publication of papers also help to let international research community to realize the needs of dissemination and outreach. A good example is “An Introduction to the Global Earthquake Consequences Database” by Emily So et al. for the 15th WCEE.

After the discussion session, financial and administrative issues were discussed. Mrs. Gozen from Pera Fine Arts explained that how they could record the expenses of the project, how they must do the reporting, what kind of expenses are eligible or ineligible, etc. Mrs. and she responded the questions of Japan partner related with these issues.
The day was closed by the thanks to Japan partner for very-well organization of the meeting.
15.02.2012

A small meeting was realized between KOERI and Yamaguchi in the third day to evaluate the study visit. The delegates discussed the weak and strong points of the study and decided the concrete steps of the project implementation after the visit.

Figure 23: Meeting in Kobe University

16.02.2012

The project team travelled to Tokyo from Kyoto and participated to Japan –UNESCO/UNU Symposium on The Great East Japan Tsunami on 11 March 2011 and Tsunami Warning Systems: Policy Perspectives
The symposium organized by the Intergovernmental Oceanographic Commission of UNESCO in Tokyo Unesco university and included many impressive subject on the earthquake and tsunami disaster and its consequences. IT’s objectives are The Great East Japan Earthquake and Tsunami on 11 March 2011 caused nearly 20,000 people to lose their lives. Major damage and destruction occurred to buildings and infrastructure in the coastal zone that was flooded, with large societal impacts and social and economic consequences. The symposium program was:

**Thursday, 16 February 2012**

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<th>Time</th>
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| 9:00 - 09:55 | **Opening Remarks**  
Moderator: Wendy Watson-Wright, Executive Secretary of IOC-UNESCO and Assistant Director-General of UNESCO  
Irina Bokova, Director General of UNESCO  
Konrad Osterwalder, Rector, United Nations University  
**The Great East Japan Tsunami: Video presentation**  
Takehiko Kusaba, International Press Division, NHK |
| 09:55 - 10:10 | **Break**                                                               |
| 10:10 - 11:30 | **Session 1: What happened during the Tsunami of 11 March 2011? What was unexpected? What is a new strategy to prepare for the unexpected?**  
Moderator: Eddie Bernard, Former Director, Pacific Marine Environmental Laboratory (PMEL), National Oceanic and Atmospheric Administration (NOAA), USA  
**What happened at that time? Report from affected areas**  
Isoo Sasaki, Mayor of Natori City |
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Feb. 10 thru 16, 2012

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<th>Time</th>
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<td>11:30 - 11:45</td>
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| 11:45 - 13:15 | MLIT’s emergency response to the Great East Japan Earthquake and recent policy changes regarding tsunami disaster countermeasures  
Koji Ikeuchi, Director of Water and Disaster Management Bureau, Ministry of Land, Infrastructure, Transport and Tourism of Japan (MLIT)  
Management and response actions by the government of Japan  
Shigeo Ochi, Counselor, Disaster Management Division, Cabinet Office  

Panel Discussion  
Moderator: Eddie Bernard, Former Director, PMEL (Pacific Marine Environmental Laboratory), NOAA (National Oceanic and Atmospheric Administration), USA  
Panelists:  
- David Coetzee, Emergency Management Planner, Ministry of Civil Defense and Emergency Management, New Zealand  
- Karl Kim, Professor, Department of Urban & Regional Planning, University of Hawaii, USA  
- Helene Hebert, Chief Researcher of Technology Development Agency France  
- Isoo Sasaki, Mayor of Natori City  
- Shunichi Koshimura, Associate Professor, Graduate School of Engineering, Tohoku University  
- Hideki Yamaguchi, Director, Fire and Disaster Management Division, Fire and Disaster Management Agency (FDMA)  
- Kouji Ikeuchi, Director of Water and Disaster Management Bureau, MLIT  
- Shigeo Ochi, Counselor, Disaster Management Division, Cabinet Office  

| 13:15 - 14:15 | Lunch Break                                                           |

**Session 2: Run away from the Tsunami! Why do some people not evacuate? Education in schools and communities.**

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<th>14:15 - 17:00</th>
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| 14:15 - 17:00 | Tsunami evacuation from a socio-psychological point of view  
Naoya Sekiya, Associate Professor, Media Communications Studies, Department of Sociology, Toyo University  

Implementation of Tsunami disaster education in schools and communities  
Masashi Suenaga, Former Director, Fire Management and Disaster Reduction Division, Kamaishi City  
Community preparedness near high potential earthquake and Tsunami source areas: The example of Shizuoka prefecture  

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**Takayoshi Iwata, Director, Crisis Preparedness and Management Department, Shizuoka Prefecture**

**How to enhance public awareness at community level?**  
Kiyoshi Natori, Director General, Asian Disaster Reduction Center, Japan

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<th><strong>Panel Discussion</strong></th>
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| **Moderator:** Ardito Kodijat, Jakarta Tsunami Information Center, UNESCO  
**Panelists:**  
- Lorna Inniss, Deputy Director, Coastal Zone Management Unit, Barbados  
- Lori Dengler, Professor, Humboldt State University, USA  
- Irina Rafliana, Researcher, Indonesian Institute of Sciences  
- Naoya Sekiya, Associate Professor, Media Communications Studies, Department of Sociology, Toyo University  
- Takayoshi Iwata, Director, Crisis Preparedness and Management Department, Shizuoka Prefecture  
- Kiyoshi Natori, Director General, Asian Disaster Reduction Center, Japan |

| **17:00 - 18:30** | **Poster Session** |

**Friday, 17 February 2012**

**Session 3: Towards the improvement of standard operational procedure (SOP) of Tsunami warning centers. What is an understandable and effective Tsunami warning?**

| **9:00 - 10:45** | **Moderator:** Mr. Rick Bailey, Chair of Indian Ocean Tsunami Warning System (IOTWS), Bureau of Meteorology, Australia  
**What was the great East Japan Earthquake and Tsunami?**  
Kenji Satake, Professor, Earthquake Research Institute, The University of Tokyo  
**Enhancement of tsunami warnings through the use of geodetic observations on land and on the bottom of the ocean**  
Hiroshi Yarai, Executive Officer for Earthquake Investigation, Geospatial Information Authority  
**JMA’s response to the Off the Pacific Coast of Tohoku Earthquake and planned improvements of Tsunami warning**  
Osamu Kamigaichi, Director, Seismological and Volcanological Department, Japan Meteorological Agency |

| **10:45 - 11:00** | **Break** |

| **11:00 - 12:00** | **Linking international tsunami research and science with operational tsunami warning systems**  
Fumihiko Imamura, Professor, Graduate School of Engineering, Tohoku University |

**Panel Discussion**

- Chip McCreery, Director, Pacific Tsunami Warning Center
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*Francois Schindele, Coordinator, France Tsunami Warning Center*
*Daniel Jaksa, Co-Director, Joint Australian Tsunami Warning Center*
*Gerassimos Papadopoulos, Research Director, National Observatory of Athens*
*Kenji Satake, Professor, Earthquake Research Institute, The University of Tokyo*
*Hiroshi Yarai, Executive Officer for Earthquake Investigation, Geospatial Information Authority*
*Osamu Kamigaichi, Director, Seismological and Volcanological Department, Japan Meteorological Agency*
*Fumihiko Imamura, Professor, Graduate School of Engineering, Tohoku University*

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<td>Session 4: The role of Mass Media: Global media collaboration in response to natural hazards and preparedness</td>
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<td>Moderator: Akira Ikegami, Journalist</td>
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<td>Panelists:</td>
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<td>• Noboru Yamazaki, Deputy Chief, Commentator Commission, Japan Broadcasting Corporation (NHK)</td>
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<td>• Megumi Nishikawa, Expert Senior Writer, The Mainichi Newspapers</td>
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<td>• Martin Fackler, Tokyo Bureau Chief, New York Times</td>
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<td>• Régis Arnaud, Tokyo Correspondent, Le Figaro</td>
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<td>• Fadi Salameh, Tokyo Bureau Chief, Aljazeera</td>
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<td>14:30 - 14:45</td>
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<td>14:45 - 16:45</td>
<td>Session 5: Strengthening international cooperation: Role of international organizations</td>
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<td>Moderator: Wendy Watson Wright, Executive Secretary of IOC, UNESCO</td>
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<td>Current status of international coordinating structure of tsunami warning and mitigation systems: towards establishment of globally harmonized system</td>
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<td>Yutaka Michida, Professor, Atmosphere and Ocean Research Institute, The University of Tokyo, Vice-Chair of IOC</td>
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<td>Recovery of the Tsunami affected areas and building a nature harmonious society</td>
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<td>Kazuhiko Takeuchi, Vice-Rector, United Nations University</td>
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<td>International cooperation and development partnership</td>
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<td>Shinya Ejima, Director General, Global Environment Department, Japan International Cooperation Agency (JICA)</td>
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**Panel Discussion**
Moderator: Wendy Watson Wright, Executive Secretary of IOC, UNESCO
Panelists:
• Maria Ana Baptista, Professor, ISEL, University of Lisbon
• Denis Peter, Project Officer, Directorate General for Research & Innovation, European Commission
Conclusions

A comprehensive survey was undertaken in Japan involving Disaster Prevention Divisions, Universities and Research Centers. The project team obtained very detailed and productive information from the Disaster Prevention Division Hokkaido prefectural government, especially on the operational use of existing systems. Extensive information has been accumulated on furniture vulnerability functions, indoor space microzoning and casualty risk modeling from Hokkaido University. The visit to the E-Defense Laboratory (Hyogo Earthquake Engineering Research Center National Research Institute for Earth Science and Disaster Prevention-NIED), “the World’s largest and best performance shaking table”, provided crucial information on testing real-scale buildings and infrastructural systems to real earthquake conditions as a tool for ultimate verification, where the effects of reinforcement could be evaluated. Definition of testing strategies, such as violent motion of heavy equipment, scattered items, littered environment or calm-environment in short-period ground motion and violent motion of wheeled equipment in long-period ground motion, have been acquainted with. Structural performance of high-rise buildings and benefits of retrofitting method have also been identified. The experience of E-Defense laboratory and it’s experiments are provided to the Project with a DVD and a guide-book for safe furniture setting including information on how we can protect ourselves from the moving or/and falling furniture during the earthquakes.

A high level of understanding was obtained on the studies in Japan on furniture, indoor risk of earthquakes and efficiency of furniture overturning protection devices during earthquakes. Valuable information has been gathered at Kyoto University on damages, human behavior and recovery process of residents, together with an understanding of the relevant survey methodology.

The visit led to the decision that Japan partner will share its know-how in the third partnership meeting which is going to be held in Bulgaria in July, 2012. Target group of the WBT system development, expected report from Japanese counterpart and importance of publication efforts have all been identified with the agreement to make effort to publish co-authoring papers in some international conferences.
The project team also benefitted from the opportunity to participate in Japan –UNESCO/UNU Symposium on The Great East Japan Tsunami on 11 March 2011 and Tsunami Warning Systems: Policy Perspectives.

This survey helped in great detail to clarify how Japan responded against the shaking and also non-structural damage in the houses during an earthquake. It also provided an understanding of the similar conditions to EU countries, educational needs, background, skills, work and the training expectations of the craftsmen regarding the indoor safety and level of the Japanese partner potential supports. We have concluded that all necessary input for the e-learning modules to be developed within the SISMILE project have been accumulated during this comprehensive survey visit.