UJNR Panel on Wind and Seismic Effects **Panel Update**

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HIGHLIGHTS OF THE 41st JOINT MEETING OF THE PANEL ON WIND AND SEISMIC EFFECTS 18-23 MAY 2009

The 41st Joint Meeting of the Panel on Wind and Seismic Effects was conducted during 18-23 May 2009, Japan. The Panel's technical meetings were held during 18-20 May at the National Institute for Land and Infrastructure Management, Tsukuba, Japan followed by technical site visits during 21-23 May in Tokyo, Japan.

<u>Technical Meetings, 18-21 May</u>

- 22 technical presentations (9 from US-side and 13 from Japan-side)
- Seven themes
  - Next-Generation Building and Infrastructure Systems
  - Dams
  - Wind Engineering
  - Transportation Systems
  - Storm Surge and Tsunami
  - Sustainable Design for Buildings and Infrastructure - Focus on Natural Disaster Prevention
  - Disaster Resilient Buildings and Infrastructure
- Technical presentations highlighted important work by the US and Japan Panel member organizations:
  - useful information gained about Japan's public works projects and civil engineering research and their applications of research into practice,
  - effective work in
    - + evaluating earthquake damage systems for bridges and shake table testing on bridge columns,
    - + earthquake disaster management in Japan and disaster recovery processes,
    - + analytical and experimental research on wind engineering and tornado induced loads and assessing tornado building damages
    - + real time disaster information systems,
  - opportunities for systematic modeling of earthquake response of dams and stability evaluation of dams, dam remediation and dam evaluation performance
  - new technologies in remote sensing/data fusion for infrastructure hazard mapping, remote sensing data integration: excellent opportunities for partnering with Panel's Task Committees and other UJNR Panels,
  - research demonstrates basis for major revisions of highway bridge design criteria,
  - findings influence US and Japan structural engineering research and contribute to revisions and creation of both country's codes and standards.
- Consideration will be given to create a new Task Committee on Seismic Monitoring of Ground and Built Environment as a renewed former Task Committee A on Geotechnical Engineering and Ground Motion.
- The Panel's results will be more widely disseminated by greater use of e-mail, the Panel's eNewsletter, and the Panel's Web Site.
- The Panel encourages partnering opportunities identified by respective Task Committees.
- The Panel encourages each Task Committee to develop methods to evaluate progress of their respective Task Committee.

Photo 1. Group Photograph of US-Japan Members attending 41st Joint Meeting of the Panel on Wind and Seismic Effects

Technical Site Visits, 21-23 May 2009

During the 41st Joint Panel Meeting the delegation visited seven sites. Highlights follow:

1. Tokyo Rinkai Oh-hashi Bridge

The Tokyo Rinkai Oh-hashi Bridge also tentatively named the Tokyo Port Seaside Bridge is 1,618 m long over the water and 2,933 m long in its entirety. It connects reclaimed land outside the central breakwater and the Wakasu area of Tokyo. When it is opened in 2011, the Tokyo Port Seaside Road will facilitate commercial highway transportation in and around the Tokyo Port easing traffic congestion in roads serving the Tokyo Bay area.

The uniqueness of this bridge design is its requirements not to interfere with the flight patterns of Haneda Airport and yet be high enough over the shipping channel to accommodate cargo ships. If this bridge's height was not controlled by the flight limits, a suspension-type design would have been the most economic choice. The selected design was a high strength steel (70 ksi) truss bridge with structural height of 87.8 m and headroom (distance below substructure) of 54.6 m. The bridge's lower foundation is the main pier that supports the bridge's 760 m composite box truss (160 m end spans and 440 m center span). Soft clay covers the bottom of the Tokyo Bay where the pier is located. This continuous and composite bridge poses a huge challenge of its substantial self weight and high corrosion resistance requirement area. Steel coating and welding standards are much higher than required. The clay layer is about 30 m thick. A "steel pipe sheet pile well foundation," was used in which temporary steel pipe sheet pile cofferdams serve as the foundation. Truss members are installed by various cranes (land and floating). The truss will be transported by barge using one of Japan's three largest floating cranes. When in place the upper deck truss will be installed using a 450 ton crane to lift members to the deck. Sliding bearings are installed for seismic isolation and the piers. The bridge is orthotropic steel to limit the fatigue with 0.5 m steel expansion finger joints. The bridge is designed for a 100 year life. The bridge cost is estimated to be 98 B yen ($1 B).

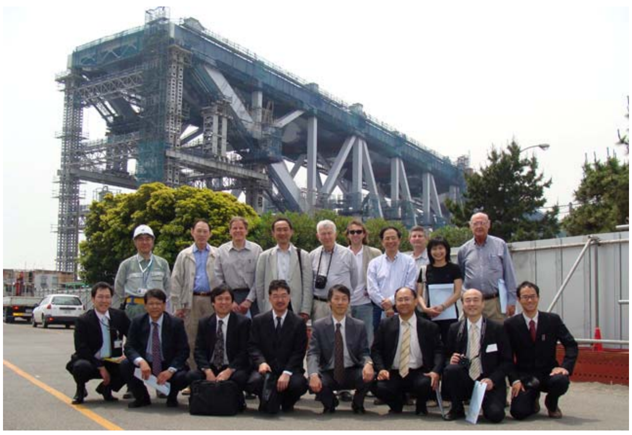

Photo 2. Group Photograph of the Delegation at Tokyo-Rinkai Oh-hashi Bridge

2. **Tokyo International Airport (Haneda) New Runway Design and Construction**

Haneda Airport is constructing a fourth runway (off shore) to accommodate the spiraling increase in demand for air mass transportation. A new Passenger Terminal 2 was conducted in February 2007. This fourth runway (Runway D) will serve domestic and international flights easing congestion at Narita International Airport about 60 km northeast of Tokyo. The new 2,500 m runway is a combination of land fill reclamation and a bridge. The landfill is located in Tokyo Bay and its adjoining bridge is in the Tama River estuary at Tokyo Bay. The runway elevation ranges from 14 m to 17 m above sea level. This runway is connected to Haneda Airport by a 260 m bridge section.

The bridge pier jackets are 1.6 m diameter by 80 m long. Bridge deck sections are prefabricated in sets of six piers each with its superstructure measures 63 m by 45 m with cross bracing to resist the flow of the Tama River. These sections are floated to site. When placed, the weight of the sections sinks about 20 m into the sea bed. They are then vibrated to a depth of 70 m. The piers are aluminum with stainless steel jackets starting 1.5 m below the splash zone and to the deck steel substructure that is covered with titanium plates. The superstructure runway is super high strength precast fiber concrete. One hundred eighty nine jackets make up the bridge. The expected life of the bridge is 100 years.

The landfill consists of sand compaction piles in alluvium clay layer, riprap perimeter serves as wave dissipaters, and 12 m to 20 m deep dredged earth mixed with cement is placed over a sand mat with compacted sand around the perimeter. The landfill is expected to sink about one meter over its life time. The runway connection to the bridge is by a roller leaf connection. The cost of the runway is about 600 trillion yen (about $6 trillion at May 2009 conversion).

3. **Disaster Management Center (DMC)**

The new national disaster management center at Ariake, Tokyo, is a regionally based, state-of-the-art, multi-function emergency management facility. When a disaster strikes, such as a major earthquake, the DMC functions as a disaster management center and a medical treatment-shelter facility. The facility includes an evacuation zone, evacuation center, stockpiling base, relief goods collection location, debris yard, emergency/restoration operation center, emergency headquarters facility, and a "spare" facility. Here, administrative agencies gather information and direct regional operations. The operation room is equipped with large-screen monitors, terminal devices, and communication equipment. The facilities include a meeting room, a napping room, and rooms for staff on standby. The design of the DMC site includes a number of features such as a water collection and reuse system that uses permeable pavement (green technology), plantings of large trees strategically positioned in the overflow area of the grounds that will serve as a field hospital in temporary tents, and decorative fountain that recedes into the ground to provide a level pathway for access to and from the field tent hospital and to the new Cancer Hospital located adjacent to the DMC.

The DMC coordinates disaster relief efforts with the Tokyo Metropolitan Area and with the Tokyo Metropolitan Disaster Relief Center in Shinjuku, Tokyo. The Center uses dedicated communication systems to communicate with its officials and staff during emergencies. Pagers worn by staff are triggered with seismic intensity of 5 or greater on the Japan Meteorological Agency intensity scale. The Center operates with three contingency plans to assist the disaster relief staff get to their offices -1) through designated roads, 2) designated metro trains, and 3) helicopters from its rooftop heliport respectively. The DMC serves a dual function during the non disaster periods as a learning center for general public disaster awareness about earthquake disaster education and demonstrations on a day-to-day basis that help prepare local residents for disaster response. The DMC provides outdoor recreation space in the surrounding park (evacuation zone).

4. **Takenaka Corporation Tokyo Main Office, Tokyo**

Takenaka Corporation's Tokyo seven story main office building opened in 2004 as a sustainable office building. Wall mounted monitors display the building's energy consumption and CO_2 emissions. This building uses natural light and wind for ventilation. Its HVAC ducts are made of used and recycled cardboard materials with an added aluminum coating. Its rooftop is designed with greenery, a large rain tank is located in the basement as a water source for toilet flushing and as emergency water supply, and an IT-based energy use management system records CO_2 emissions that are 25 percent lower than an average office building today. The building is designed to allow north-south winds to bring air into the building with greenery around the base of the building. Their "Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)", akin to the US LEED (Leadership in Energy and Environmental Design) environmental efficiency rating scheme, awarded this building an environmental efficiency rating of 4.9 (5.0 is the highest rating). The office spaces on the 2nd story and above have open layout and its three center cores allows sunlight into the building's interior through its cathedral glass ceiling. The building incorporates solar collectors on the building exterior for heating and ventilation and features a hybrid air conditioner using conditioned air with natural ventilation that flows through louvers in the outer walls and through a porous floor. The conditioned air is cooled during the day using ice produced during evenings in its roof top thermal storage units. The cafeteria accommodates 350 persons and can be used as a general purpose room for large meetings and conferences. Building temperatures are maintained near 24 degrees Celsius. The building is designed to be operational for a one week period following a major disaster and serves as a disaster relief center for its staff.

The structural framing system consists of an outer braced structure and a universal floor beam with buckling resistant braces. The steel beams are coated with fire resistant calcium silicate sheets. Building equipment is tightly fixed to the building's structural system permitting the building to be operational after an earthquake. The structure uses a uniform span measuring 10.8 m by 10.8 m made up of CFT columns with a diameter of 500 mm, an "external bracing structure" with buckling-restrained braces laid out, and "universal floor beams" made up girders and beams of a uniform beam depth of 450 mm. With a disperse layout of air conditioners in the exterior brace sections, outside air is directly drawn in from the exterior wall louvers, exhausting through the light wells, the building uses a four-mode hybrid air-conditioning system using natural ventilation. With the universal floor beams, the air-conditioning ducts do not penetrate the beams, but are hung under the beams, so with a standard office building floor height of 4.1 m, a minimum 3 m ceiling height has been maintained. The direct ceiling "new ceiling system" consists of punching metal underneath covers and lighting fixtures.

5. **Shimizu Institute, Shimizu Corporation**

The Shimizu Corporation's Research Institute Headquarters was built in 2003 using Green Building Concepts that demonstrated a 43% savings in energy costs and a 35% reduction in CO_2 emission during the building's first 5 years of operation. The research institute is designed in a campus like setting with various testing facilities. For example, its structural testing laboratory is equipped with a 6 MN testing machine, a reaction floor, and vibration testing systems. The wind tunnel testing laboratory is a return boundary-layer wind tunnel 3.5 m wide, 2.5 m high, and 20.3 m long that generate wind up to 35 m/s. Included are a multi-point wind velocity and direction measuring system, a 512-point simultaneous pressure measuring system, and various simulation systems. Also the tunnel is equipped to simulate snow drift on the roofs and around buildings. A 1,940 m biotope (pond with fish and birds) is located in the foundation space of the original building that was demolished for construction of the campus of individual research laboratories.

The main office building adjacent to its labs was designed for energy savings technologies. Air is supplied through the floor carpets reducing the need for ducts. The office work space incorporates "personal air diffusers" under desks to help cool the workers legs. Room air temperatures average 24 degree celsius. Task and ambient lighting and information systems optimizes energy use and electricity. The ice storage system cools water in the evening for use during warm summer days for cooling. Gradation blinds help reflect the sunlight away from the building. The building's CASBEE "Comprehensive Assessment System for Building Environmental Efficiency rating is 3.2. Paper waste and biomass are used to generate electricity through an energy conversion system. The building is installed on seismic isolators installed in an underground reservoir that isolates the building through buoyancy. The six main columns are installed with rubber bearing base isolators. The core suspended system on one of its buildings employs isolators on the roof with the building suspended around a central core. This technique is similar to those used for pagodas.

Of particular interest is Shimizu's research into a Green Float Botanical Future City. This concept involves erecting a series of 1000 m towers (inverted cones) where residents live in about 150 m^2 - 200 m^2 units starting at the 700 m level and research and plant factories are located below the residential level. The towers are constructed on 3 km diameter floating artificial islands located in the equatorial Pacific Ocean. A waterside resort is at the oceanfront. A cluster of islands could accommodate 1 million persons. This botanical city design concept is aimed at the 2025 time frame having the intent to: provide living spaces for the increasing population; reduce CO_2; conserve energy; reduce waste products; and preserve the environment. Ocean thermals and solar energy is expected to be the primary energy source. Cooling will be from several thousand meter high pipes in the atmosphere and also in deep ocean water. CO_2 will be dumped into the ocean using a 1 km to 1.5 km deep pipe. The inverted cone tower is proposed to be constructed of honeycomb materials using magnesium from the sea. Shimizu philosophy in developing their proposed living base addresses Albert Einstein's quote, "We can not solve problems using the same kind of thinking we used when we created them".

6. **Japan Meteorological Agency**

The visit was divided into three topics: seismic, tsunami, and volcano warnings.

Seismic Warnings. Japan experiences about 100,000 earthquakes per year – most of them small. Earthquakes which can be felt by the population average about 2,000 per year. There are in excess of 4,248 seismic intensity observing stations in Japan operated by JMA, local governments (the majority of stations), and NIED. Seismic warnings are sent out through multiple communication channels within 2 minutes after the event for earthquakes estimated to be equal to or greater than 3 on the Japanese intensity scale. The levels of response are scaled with the intensity of the earthquakes. A simple shake map of the predicted timing and intensity of the earthquake is used for the forecasts and seismic stations are used for verification. Currently, there is a project called the Tokai Earthquake Prediction Project designed to provide early prediction of a possible 8 or greater magnitude earthquake in a region west of Tokai that would severely impact the Tokyo region. The project is attempting to simulate pre-seismic strain rates 1 or 2 days prior to a major event using a large array of strain gages in the region. If the strain indicates that an earthquake is imminent, this information is given to high level government authorities.

Tsunami Warnings. If the estimated height of the tsunami exceeds 3 m, a warning is given within 2 or 3 minutes of the seismic event. For estimated heights below 3 m, a tsunami advisory is given. JMA also provides tsunami information for the Northwest Pacific region and to most Asian countries.

Volcano Information Service. There are currently 108 active volcanoes in Japan. They are monitored by combinations of seismic sensors, TV cameras, and GPS monitoring (for large ground motion). Warnings are provided if necessary. There are 5 levels of warning, with level 5 being the highest, meaning a large eruption is imminent or underway and evacuation is necessary. JMA also provides volcanic ash advisories to civil aviation for aircraft safety. JMA is one of only nine stations in the world offering such advisories.

7. **Nippon Life Insurance Company, Marunouchi Building**

This headquarters building of Nippon Life Insurance recently received an award for its energy and environmental savings. Its façade (the base of the building's front) corresponds to Tokyo's historic 31 m height line with the main building office tower body set back. Seismic vibration control is by "w-pair Mullions" installed in the exterior walls. These paired precast columns (w-paired mullions) are hinged at their connections to the top and bottom structural beams with vibration control panels installed between the granite precast columns. The building's seismic damping system is located in the top floor. The building is not designed against terrorist attacks or for fire loads. During disasters occupants either descend to street or ascent to the roof for evacuation by helicopters. Sunshine heat gain is reduced by auto blinds and mullions and eves in the façade. Energy savings are through greater use of natural lighting and light control sensors. The building achieved a 34 percent energy savings during 2006-2007 over the standard value calculated for a typical office building. The building's CASBEE rating is 3.2. The building was designed for a 100 year life.