Panel discussion at the 2013 annual meeting of the JSCE

Toward an infrastructure for a safe and secure society
Recent achievements and issues in the concrete engineering field in Japan -

Chair:

Junichiro Niwa (Tokyo Institute of Technology)

Panelists:

Kyuichi Maruyama (Nagaoka University of Technology)

Hikaru Nakamura (Nagoya University)

Michitoshi Iwata (Tohoku Area Construction office, JR East)

Yoshitomi Kimura (CAESAR, Public Works Research Institute)

Koichi Maekawa (The University of Tokyo)

Photo 1 Panelists

Photo 2 Brief introduction by Prof. Niwa

This panel discussion was held by the Concrete Committee as part of the Japan Society of Civil Engineers 2013 Annual Meeting at the Tsudanuma campus of Nihon University on September 4, 2013. With proceedings led by Prof. Junichiro Niwa, current chair of the Concrete Committee, five speakers gave presentations focusing on the development of infrastructure for a safe and secure society: Prof. Maruyama (achievements of the subcommittee for evaluation of tsunami forces), Prof. Nakamura (achievements of the subcommittee for construction anchors), Dr. Iwata (issues with railway structures and countermeasures), Dr. Kimura (maintenance of highway structures), and Prof. Maekawa (approaches used in the JSCE Standard Specifications for Concrete Structures). These presentations were followed by a question and answer panel session.

Topic 1: Tsunami forces and the resistance of bridge structures (Prof. Maruyama)

Following catastrophic damage to bridge structures by the tsunami initiated by the huge earthquake of March 11, 2011, the JSCE Concrete Committee set up a research committee for the “evaluation of tsunami forces on bridge structures” with Prof. Maruyama in the chair. While almost half of the research committee members were from the field of concrete engineering, the other half were from diverse other fields such as coastal engineering and bridge engineering so as to ensure that tsunami forces were evaluated from various points of view. Prof. Maruyama reported on the achievements of this committee.

Tsunami forces act on whole structures and are monotonic over a comparatively long time period. In this respect, they contrast with seismic forces, which are cyclic over a comparatively short time period. The committee conducted a field survey of 1,793 bridges in tsunami-hit areas and compared them with a predictive equation for the resistance of bridges to tsunami forces as proposed by Prof. K. Kosa of Kyushu Institute of Technology. This work confirmed that the equation has an accuracy problem.

To investigate the issue, the washing out of the Numata overpass was modeled in an experiment and through a numerical simulation. This revealed that bridges tend not to be swept away under very deep water flows because a negative lifting force arises; however, solitary waves result in a large lifting force and a bridge deck is then easily swept away.

The major outstanding issue that needs to be addressed is how to model the horizontal force and lifting force imparted to bridge decks according to tsunami characteristics, such as fluid velocity and height of the solitary wave, and bridge characteristics, such as deck dimensions and distance from the bridge deck to the water surface.

Photo 3 Presentation of Prof. Maruyama

Topic 2: Report from the subcommittee on construction anchors (Prof. Nakamura)

With the aim of establishing design and construction standards for construction anchors, the JSCE Concrete Committee set up a research committee in June 2012, assigned by Japan Construction Anchor Association. The committee was originally scheduled to finish work by March 2013, but this was extended until March 2014 in light of the Sasago tunnel incident of December 2, 2012. In this

incident, a 140 m length of concrete roof panels, which were fixed by anchor bolts and used for air ventilation, fell away and crushed a number of cars passing through the tunnel (which lies along the Chuo Expressway). There were nine deaths and two injuries. The secretary-general of the research committee, Prof. Nakamura, explained the activities of the committee.

Photo 4 Presentation of Prof. Nakamura

The anchor bolts used to hold up the roof panels in the Sasago tunnel were of the resin type. A field survey indicated that some of the anchor bolts did not satisfy the pull-out strength requirements due to filling loss of the resin. Inspections of anchor bolts are based on close visual observation. It is important to keep a proper record of the construction process as well as information about components that are attached to the anchor bolts.

Other outstanding issues that should be addressed are the establishment of methods for testing such characteristics as the long-term durability of anchor bolts, the development of a verification equation applicable to real-world situations, particularly in the civil engineering field, the development of a qualification system for construction and inspection, and the sharing of information at each stage of design, construction and maintenance.

Topic 3: Toward safe and secure railway structures (Dr. Iwata)

Dr. Iwata of JR East gave a presentation about how the company has learned restoration techniques from the experience of past earthquake damage, how they made use of them to ensure rapid restoration of Tohoku Shinkansen services after the 2011 Great East Japan Earthquake, and what the remaining issues are.

In the 1995 Kobe earthquake, shear failure of RC columns in a rigid-framed viaduct occurred. Following that disaster, the retrofitting of structures that were thought to be prone to shear failure was carried out with renewed urgency. Then, in the 2004 Niigataken-Chuetsu earthquake, it was observed that the apparent shear span to effective depth ratio was reduced by the confinement effect of concrete blocks placed near a column basement. When Tohoku suffered the great 2011 earthquake, all columns and piers thought susceptible to shear in the JR East provision had been already retrofitted. As a result,

there were no notable collapses of such structures.

Photo 5 Presentation of Dr. Iwata

JR East consolidates all information on incidents of damage at a central office. Using this information, a restoration plan is rapidly developed, and details of each countermeasure are transmitted from the central office to the site. In the Great East Japan earthquake, restoration was achieved very quickly by sending directives from the central office within 24 hours of the earthquake.

As for outstanding issues arising from the Great East Japan earthquake, there is a need to address the seismic retrofitting of electric catenary poles for the Shinkansen and the enhancement of seismic capacity of other railway structures based on the assumption that an earthquake occurs directly beneath the Tokyo Metropolitan Area.

Topic 4: Efforts for the maintenance of road bridges (Dr. Kimura)

Dr. Kimura of the Center for Advanced Engineering Structural Assessment Research (CAESAR), part of the Public Works Research Institute, gave a presentation on recent work on the maintenance of road bridges.

Photo 6 Presentation of Dr. Kimura

The majority of road bridges in Japan are managed by local governments. Recently, quite thorough inspections of even such locally managed structures have become the norm, but there are still issues related to the development of a rational scheme for the maintenance of road bridges, particularly considering that the number of deteriorated structures is increasing.

At CAESAR, they are carrying out clinical research on road bridges, involving surveys and investigations based on a series of loading tests on real dismantled bridges with damage, investigation of material decomposition and material characteristics, and proposals for loading capacity evaluation methods. They are also making great efforts to accumulate data from real structures, such as tracking re-deterioration after repair.

Topic 5: Approaches used in the Standard Specifications for Concrete Structures (Prof. Maekawa)

Prof. Maekawa of the University of Tokyo, who was head of the design working group, gave a presentation on approaches used by JSCE in developing the Standard Specifications for Concrete Structures.

In revising the seismic design section for the 2012 version of the Standard Specifications, a determination method for failure modes was introduced for the first time. Further, the concept of seismic design for cases where seismic loading exceeds the design value was clearly described to the degree possible. That is, the significance of maintaining redundancy (a margin of safety ratio for the system as a whole even when some elements are damaged) and robustness (the ability of a system to resist some attack from external environment by internal protection) was explained.

Photo 7 Presentation of Prof. Maekawa

In the Great East Japan earthquake, structures themselves were restored much more quickly than after past earthquakes. As a result, logistical problems such as securing repair materials and supply routes to the sites came to have a more prominent influence on repair time. The 2012 version of the Standard Specifications introduced the concept of “restorability” as an index of how difficult it is to restore structural performance lost through incidental actions such as earthquakes. It includes not only the

physical, as in the difficulty of restoring a structure itself, but also non-physical aspects such as securing materials and restoration methods.

Questions and Discussions

Q. The proper maintenance of structures will require many engineers with appropriate skills in maintenance and inspection. How should we educate them?

A. The way to improve inspection skills is for a person to visit many actual sites accompanied by someone well-acquainted with the situation. Observation of not only the visible surface but also the interior state (by cutting through structures) is necessary to learn their failure behavior. As of now, we have more than 10,000 concrete diagnosis engineers. It appears that private companies are coming to realize the importance of these qualifications. However, there are still a lot of problems with such technical capabilities in the public domain, which is the ordering side of infrastructure development. (Dr. Kimura)

A. I have seen many instances of a person being able to distinguish deterioration states in the case of experimental specimens but not in real structures. In my opinion, there is no need to carry out inspections using the same method in all cases. Concrete diagnosis engineers can quickly inspect a structure using comparatively simpler tools and then, if they find any defects, more advanced engineers can be brought in for a secondary inspection. However, the most critical issue is that the budget for maintenance is small. One way to solve this problem might be to develop a system whereby the necessary funds are collected from local residents after explaining the importance of infrastructure maintenance. Engineers at local universities and other associations can support the work based on the idea of “local people solving local problems.” (Prof. Maruyama)

A. At Nagoya University, we established NEXCO-Central and the Nagoya University Bridge Model with Restoration and Integrated Deterioration for Global Engineers (N2U-BRIDGE). Using deteriorated bridge members removed from real sites, bridge models were reconstructed in the university with the support of NEXCO-Central and other universities and prefectures in central Japan. These models are being used to educate engineers in bridge maintenance. I recognize the importance of the clinical style of education system for inspection engineers; that is, not only desk-based education but also carrying out inspections on actual structures. (Prof. Nakamura)

A. Among the JR companies, we have the problem of passing techniques between generations of engineers because the number of engineers in the middle group, those who joined just after privatization, is small. The older generation, in particular, prefer to explain by speaking and/or showing physical objects. In my opinion, engineers must at least be capable of passing accurate information from work sites to central office. In our organization, new construction is managed separately from maintenance, with the construction group and the maintenance group, respectively, responsible for these areas of work. However, information about construction is necessary when dealing with maintenance questions. Therefore, communication between various groups is very important. (Dr. Iwata)

A. Organizations in which the same people manage both new construction and maintenance tend to address emergency problems rapidly. If information has to be carried back to a central office after a site investigation, restoration work may be delayed. In the case of emergency countermeasures, such as after an earthquake, an engineer should never say, “It’s not my job.” (Prof. Maekawa)

Q. In Japan, railway companies tend to take restorative action after an earthquake comparatively early. Do their budgets support this?

A. “Safety has priority” is our company’s number one policy. Our budget is around ¥300 billion for the coming five years. It is true that there is competition for that money within the company. But we are using the funds in our efforts to realize a safe and secure society. (Dr. Iwata)

Q. The recent news is that the Hokkaido Shinkansen will be constructed, so the Shinkansen infrastructure will then cover almost the whole of Japan. How can a person in the company or research institute transfer the necessary expertise to the far corners of Japan? How and where can this be done?

A. We transfer expertise through conferences such as this JSCE annual meeting, technical exchange meetings attended by all JR companies, and interpersonal exchanges among JR companies. (Dr. Iwata)

A. I feel that we need a structure of “central,” “block,” and “local” offices. Information should be shared by passing data about each local area to the central office and then disseminating the information through regular meetings with the heads of block offices. As for getting information outside the company, conference presentations, committee activities and workshops can be considered. How effective they are is not clear, but continued effort is the most important. (Dr. Kimura)

To finish this session, may I ask each panelist to say something about what is important for the “development of infrastructure for a safe and secure society?” (Prof. Niwa)

- Experience is a crucial element of effective inspection and maintenance. As Japan approaches an era of super-aged society, we might imagine a system in which experienced retirees are re-employed. (Prof. Maekawa)
- There is a tendency for tools and techniques to come first while needs remain known. I feel that it is important to bring in people from other fields because the restoration of infrastructure is affected by mechanical and electrical concerns. Fortunately, people in civil engineering tend to be good at developing human relationships. I hope we can take advantage of our ability in this area. (Dr. Kimura)
- There is no such thing as perfect safety. Our continuing efforts to learn from experience and apply what we learn before the next event is very important. So far we have managed to gradually reduce the amount of damage with every successive earthquake. (Dr. Iwata)
- It is important to understand not only how to prevent failure but also how a structure behaves after failure. My work is an example of this; I have carried out research on the post-peak behavior

of structures. I hope everyone will publish information not only about load carrying capacity but also about how it changes after failure. (Prof. Nakamura)

- Disaster prevention relies on the understanding that “we solve our problems ourselves”. I would like to see consciousness of this not only among engineers but also among the general population. The education of engineers is also important and to this end I believe the work of the JSCE research committees should not remain internal but should be reported to the wider world. (Prof. Maruyama)