Development of functional continuation technology of critical post-disaster buildings

Kenichi Sato, Research Coordinator for Advanced Building Technology
Yasuo Okuda(Ph.D (Engineering)), Research Coordinator for Disaster Mitigation of Building
Koji Ando, Head
Yoshihiro Iwata(Ph.D (Engineering)) , Senior Researcher
Toshikazu Kabeyasawa(Ph.D (Engineering)) , Senior Researcher
Standards and Accreditation System Division
Yuji Kubota, Senior Researcher, Environmental and Equipment Standards Division,
Yoshio Wakiyama(Ph.D (Engineering)) ,Senior Researcher, Evaluation System Division
Building Department

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1. Foreword

Based on the damage from the Great East Japan Earthquake and tsunami and tornadoes of recent years, we have implemented a four year integrated technology development project called "the development of functional continuation technology of critical post-disaster buildings" to develop functional continuation technology so that buildings involved in emergency and restoration activities can continue to function directly after a disaster. These initiatives aim to further the design technique and evaluation method for the functional continuation of critical post-disaster buildings to prepare for predicted future disasters like the Tokai/Tonankai Earthquake and Tokyo metropolitan earthquake.

2. Developing countermeasure technology for tsunamis and tornadoes

We have developed a design method that appropriately considers the tsunami loads that act on buildings. Static loading tests and hydraulic tests were implemented on external walls. With regards to ALC panels, which fractured and broke away from their connections, it was made clear that the ultimate strength in the hydraulic tests could be estimated from the maximum strength in the static tests. Based on the test results, we have proposed a design method considering the reduction effects of tsunami loads by the breakaway of external walls.

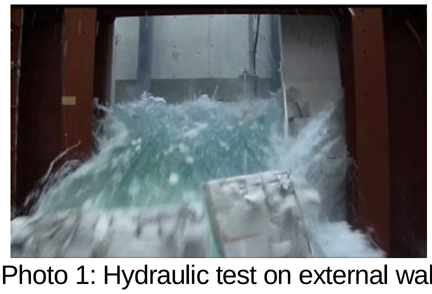

Photo 1: Hydraulic test on external walls

On damage prevention to the outer wall and the windowpane resulting from flying debris during tornadoes and typhoons: We also implemented shock resistance evaluation tests by applying the assumable force of flying debris in a tornado onto the cladding and put together a shock resistance experiment/evaluation method (plan) for flying debris, with regards to the required performance of the cladding for each of the critical post-disaster buildings classifications.

3. Developing earthquake countermeasure technology

A suspended ceiling system with a member to suppress an earthquake's horizontal vibration will be developed. Static experiments were conducted to test the strength of the ceiling sub-system, while dynamic ones tested the structural performance of the ceiling system, some of which were comprised of HVAC units and lighting fixtures.

A full-scale loading test was carried out in order to demonstrate a new structural system utilizing a wing wall. The specimen was a 1×2 span, 19m tall, five-story reinforced concrete building. The frames consisted of columns with wing walls and beams, and the gap (slit), which was generally formed at the joint between the wall and column, was shifted to the inside of the wall. From this test, it was verified that a structure's strength and stiffness could be heightened without raising the costs, and story drift during earthquakes could be reduced. This can totally mitigate the damages on nonstructural elements and beam−column joint which are often difficult to repair after the earthquake.

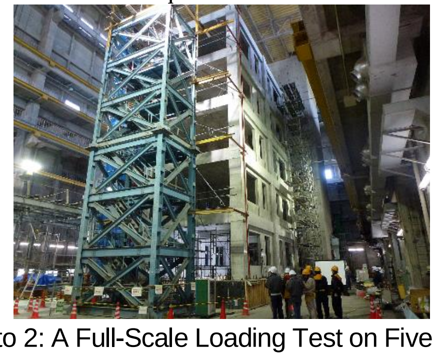

Photo 2: A Full-Scale Loading Test on Five Story Reinforced Concrete Building

As well, public hearings were conducted on local governments damaged by the Great East Japan

Earthquake, and a time line scenario was arranged up to the point that the functionality of the buildings was restored after the disaster. The useful post-disaster technologies for building facilities were also listed based on the data collection.

4. Conclusion

Based on test results provided by this research and development, the new design guidelines targeting critical post-disaster buildings are scheduled to be drawn out in the fiscal year 2016.