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ΣΕΙΣΜΟΙ ΝΕΑΣ ΖΗΛΑΝΔΙΑΣ ΚΑΙ ΙΑΠΩΝΙΑΣ

Ο καταστροφικώτατος σεισμός και το tsunami της 11ης Μαρτίου στην Ιαπωνία και το σοβαρώτατο πυρηνικό ατύχημα που προκάλεσαν στο εργοστάσιο της Fukushima εξακολουθούν να απασχολούν όλα τα διεθνή μέσα ενημέρωσης και βεβαίως την επιστημονική κοινότητα. Δεκάδες άρθρα σχετικά με σεισμούς και tsunami και τρόπους αντιμετώπισης των προβλημάτων που προκαλούν δημοσιεύθηκαν τις ημέρες μετά το συμβάν και εξακολουθούν να δημοσιεύονται σε εφημερίδες, ηλεκτρονικές σελίδες και επιστημονικά περιοδικά, πολλά εξ αυτών εξαιρετικού ενδιαφέροντος. Στο Παράρτημα αυτό συνεχίζουμε την παράθεση δημοσιευμάτων και σχολίων σχετικά με τους σεισμούς στο Christchurch της Νέας Ζηλανδίας και στο Tohoku της Ιαπωνίας, ενώ στο κυρίως σώμα του τεύχους και στην ενότητα ΕΝΔΙΑΦΕΡΟΝΤΑ – ΣΕΙΣΜΟΙ παραθέτουμε δημοσιεύματα για τους σεισμούς γενικότερα.

Πυρηνικό εργοστάσιο Fukushima πριν και μετά τον σεισμό και το tsunami

Αρ. 37 – ΑΠΡΙΛΙΟΣ 2011
ΠΑΡΑΡΤΗΜΑ

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ΣΕΙΣΜΟΣ CHRISTCHURCH ΝΕΑΣ ΖΗΛΑΝΔΙΑΣ

Earthquake Damage in Christchurch, New Zealand
(ISSMGE Bulletin: Volume 5, Issue 1)

Rolando Orense, University of Auckland
Suguru Yamada, University of Tokyo

An earthquake of magnitude 6.3 hit Christchurch at 12:58 PM local time on February 22nd. Because of the short distance to the city and the shallower depth of the epicenter, this earthquake caused more significant damage in the city than the one in September 2010 in spite of its smaller earthquake magnitude (energy). In addition to building collapses, liquefaction and geotechnical damage occurred in many parts of the city where soil condition was soft. Some photographs that were taken immediately after the quake are presented in what follows. Further damage investigation is going on now.

Photo 1 Big sand boil in Alard Street, Edgeware

Photo 2 Liquefaction in residential area in Edgeware

Photo 3 Repeated liquefaction near Bexley

Photo 4 Damaged road embankment in Avonside Drive

Photo 5 Pipeline damage at Avondale & Brighton on Avon River

Photo 6 Collapsed portion of Fitzgerald Avenue

Photo 7 Liquefaction adjacent to AMI Stadium. The ground under the stadium was stabilized with stone columns. Around the stadium, liquefaction was observed everywhere, but the stadium did not suffer structural damage.

Christchurch Earthquake (ISRM Newsletter No. 13, March 2011)

On February 22, the first of 458 earthquakes to date, March 8, struck Christchurch, New Zealand. The first quake of magnitude 2.3 occurred at 01:07 at a depth of 2km below the city. Subsequent quakes have occurred at depths from 2km to 15km. The quake having the maximum magnitude of 6.3 struck at 12:51 at a depth of 5km. Aftershocks up to magnitude 4.3 are still occurring to date.

Currently the number of confirmed dead is 165 although authorities expect the number to be significantly greater. Damage to infrastructure is estimated to exceed NZ$15billion. The quake triggered massive rockfalls and landslides. A quake map can be viewed at http://www.christchurchquakemap.co.nz/.

Tony Meyers
ISRM Vice President for Australasia

Christchurch quake validates modern building methods, expert says

The earthquake in Christchurch, New Zealand, served to confirm the value of modern construction techniques, says civil engineer John Wilson. Buildings erected within the last few decades withstood the earthquake well, while thousands of older buildings collapsed. "A lot's been learnt over the last, sort of, 40 years from a heavy research and development perspective, and that's certainly been translated now into practice," Wilson says.

Lessons to learn for quake-prone cities

TONY EASTLEY: New Zealand's Prime Minister, John Key, says 10,000 quake-affected homes, most of them older buildings, may have to be demolished.

An Australian earthquake engineering expert says the lesson for quake-prone cities around the world is that modern construction techniques do work.

John Wilson, the professor of civil engineering at Swinburne Institute of Technology, is in Christchurch to help with the urban search and rescue mission.

He spoke to AM's David Mark.

JOHN WILSON: The contemporary buildings - the sort of buildings built in the last around about 15, 20 years really have behaved very well.

It's really the older building stock that suffered.

DAVID MARK: You say the more modern buildings have done okay out of this earthquake.

What lessons are there from Christchurch for some of the other major world cities that are built in earthquake zones - San Fransisco, Tokyo, for example?

JOHN WILSON: The New Zealand modern building construction - the way they go about that – it demonstrates that those sorts of structures can behave very well.

I guess from an earthquake engineering perspective a lot's been learnt over the last, sort of, 40 years from a heavy research and development perspective, and that's certainly been translated now into practice.

So, you know, the modern buildings are much, much better than the buildings which are, you know, 30, 40, 50 years old.

And certainly by the, you know, the last 20 years in the nineties and the 2000-plus, the modern buildings have been put together with a very, very good level of design, good level of detailing and they generally perform very well.

DAVID MARK: I suppose then when you look at some of those bigger cities such as Tokyo and San Francisco you would be talking about a lot of stock that had been built prior to those dates.

JOHN WILSON: Oh absolutely, absolutely. That's the catch.

I mean like with Christchurch all those older buildings will probably be disappearing and be replaced with more modern buildings, and you end up with a more resilient city from that process.

DAVID MARK: So should this quake give those cities food for thought?

JOHN WILSON: Um, I think all earthquakes around the world when they happen, all cities which are particularly in the higher, more higher seismic regions - they always send people out to have a look to have lessons learnt.

I guess with any older city one knows that you've got older buildings there which wouldn't be compliant with current-day codes, but they're there.

And over the next month, two months, three months you'll get some reconnaissance teams of engineers coming to look at, you know - trying to learn from the damage that's occurred and what's worked and what hasn't worked.

TONY EASTLEY: Professor John Wilson from the Swinburne Institute of Technology speaking to David Mark.

And two weeks on from the Christchurch earthquake and 166 bodies have been recovered. The toll is expected to reach 200.

http://www.abc.net.au/am/content/2011/s3157718.htm

(David Mark / ABC (Australia), March 8, 2011 στο ASCE SmartBrief, March 8, 2011)

Professor raises issue of collapsed Christchurch stairwells

Stairwells are designed as a safety net for emergencies, but in Christchurch, New Zealand, people were forced to rappel down a building not because it had collapsed, but because its stairwells had crumbled. Charles Clifton, a civil engineering professor, suggested that how the stairs were anchored could have contributed to their failure.

The failure of high-rise stairwells - normally considered a lifeline to safety - during the Christchurch earthquake should be a focus of a high-level inquiry, an Auckland University academic believes.

Workers in the 17-storey Forsyth Barr building had to abseil to safety after the stairs collapsed, even though the building didn't. The Hotel Grand Chancellor's stairwells also disintegrated into rubble.

Charles Clifton, an associate professor of civil engineering, was in the city during the quake giving a seminar on assessment and retrofit for quake-affected buildings. In the aftermath, he has helped to assess buildings for civil defence.

Stairs in multi-storey buildings have a fundamental design philosophy, Professor Clifton said.

Because building levels move relative to each other in a quake, stairs are typically fixed at the top, however, they are supported on something that allows them to slide at the bottom.

While investigations would ultimately reveal the causes of the individual collapses, Professor Clifford said there were generally two reasons for failure.

First, the stairs could have moved off their supports - of which he was doubtful. More likely, stairwells were fixed at both the top and bottom.

"If, for any reason, the bottom is prevented from sliding then what happens is that you've got two floors moving with a lot of force - if you've got a stair that's rigidly fixed between them and is not able to slide, then the stairwell will break its back.

"Stairs are particularly vulnerable unless they're properly detailed to allow the sliding to occur."

Professor Clifton said the Building Code requires that people be able to exit buildings in the event of a quake without specific reference to stairs.

"I've seen the search and rescue people picking through the stairs. There will be an inquiry and that'll be one of the areas to focus on."

Hotel Grand Chancellor owner, Frank Delli Cicchi, said he could not comment on the building's stairwells until he had received a report from structural engineers.

(Yvonne Tahana / The New Zealand Herald, March 8, 2011 στο ASCE SmartBrief, March 8, 2011)

Repairs in Christchurch could soar to $20B, building exec says

Rebuilding earthquake-stricken Christchurch, New Zealand, could cost $20 billion, much more than the $15 billion forecast by the New Zealand Treasury, said Mark Binns, chief executive of the infrastructure division at Fletcher Building. In an interview, Binns suggested that workers might need to be imported from around the world, but doing this would exacerbate the scarcity of temporary accommodation in the city.

The cost of rebuilding Christchurch could exceed Treasury predictions by $5 billion, a Fletcher Building executive has estimated.

The company's infrastructure chief executive Mark Binns told Radio New Zealand this morning his rough calculations put the Christchurch earthquake repair bill at $20 billion.

That exceeds a Treasury forecast showing the earthquake costing up to $15 billion and knocking New Zealand's gross domestic product back by 1.5 per cent this year.

Mr Binns said he had been amazed by the scale of the damage the February 22 earthquake had inflicted on Christchurch city centre and its eastern suburbs.

It would require a massive international effort to rebuild the city, he said.

"It is a sobering and humbling experience to see the devastation. The magnitude of the damage compared to the last quake is just an order of magnitude more. It's a game-changer and needs a rethink."

That massive damage meant there would be a "significant margin of error" in the Treasury cost forecasts, he said.

The informal estimates he had written put the cost at $20 billion.

He said Fletcher Building was likely to need to import workers from around the world for its part of the repair job.

They would add to what was already a desperate and widespread need for temporary accommodation in the city.

"After the first quake we thought we might be able to do all the work with Canterbury people. That has definitely changed. Now it's just a question of how far afield we have to go."

He was sure repair work could begin more quickly than after the original 7.1 magnitude September 4 earthquake.

The Earthquake Commission (EQC) already had large staff numbers in their offices to deal with that quake and many jobs were already under way, he said.

"This time round clearly some lessons have probably been learnt in how to speed the work up."

(Stuff / The New Zealand Herald, March 9, 2011 στο ASCE SmartBrief, March 9, 2011)

Water-filled dam helps earthquake recovery in New Zealand

Engineers in New Zealand have installed a 50-meter-long water-filled flexible dam to hold back river water while they inspect a bridge foundation in earthquake-damaged Christchurh. The device was imported from the U.S. in 2009 and has been used only twice before in New Zealand. "It's quite a new technology [but] it's quite simple," said Graham Brown, project manager for RST Environmental Solutions.

Inflatable dam enables bridge inspection

An inflatable dam has been set up to allow engineers to inspect the quake-damaged Avondale Rd bridge.

The 50-metre long "Aquadam" holds back water from the bridge foundations, allowing engineers to see the extent of quake damage.

RST Environmental Solutions project manager Graham Brown said it was only the third time the Aquadam has been used in New Zealand.

"It's quite a new technology [but] it's quite simple," he said. The "dam" is inflated using river water.

The Aquadam, which was imported from the United States in 2009, had also been used to aid Ruby Bay bypass construction work near Nelson.

Engineers inspect the Avondale Rd bridge with the help of an Aquadam.

(Carys Monteath / The New Zealand Herald, March 9, 2011 στο ASCE SmartBrief, March 9, 2011)

SEI Team's New Zealand Earthquake Investigation -- April 2011

An ASCE-authorized Structural Engineering Institute reconnaissance team of five engineers traveled Monday, April 4, to Christchurch, New Zealand, to explore the causes of damage to infrastructure as a result of the magnitude 6.3 earthquake on Feb. 22. The team is being led by Robert Pekelnicky, P.E., S.E., LEED AP, M.ASCE, a structural engineer who is an associate principal at Degenkolb in San Francisco and is a member of the ASCE/SEI Seismic Rehabilitation of Existing Buildings Standards Committee. In this exclusive daily diary for ASCE, Pekelnicky relays the first-person experiences that he and the SEI team are going through in the earthquake zone.

Day 1 – Monday, April 4

We all met up at 9 p.m. Saturday night at the International Terminal at San Francisco International Airport. The team consists of Brian Kehoe from Wiss, Janney, Elstner, who was with me on the SEI reconnaissance team last October after the September earthquake outside of Christchurch; Owen Rosenboom, also from WJE; Charlene Hails of MRP Engineering, and Matthew Speicher of the National Institute of Science and Technology. All of us are members of the ASCE/SEI Seismic Rehabilitation of Existing Buildings Standards Committee, with the exception of Matthew, who is joining us on behalf of the National Earthquake Hazards Reduction Program. We all boarded the plane for the long 12-hour flight to Auckland followed by a short flight to Christchurch, where we would arrive around 8:30 a.m. Monday local time.

Aside from being really long, the flight was uneventful. Clearing customs was another story. We were all pulled out of line because we indicated we were structural engineers here to look at earthquake damage. They wanted to make sure that we were not here to actually try to drum up and do some business without proper visas. Fortunately, we had our letter from ASCE stating our purpose, which is to observe the effects of the February earthquake on buildings and meet with local engineers and academics to glean information that can be taken back and incorporated into *ASCE 31: Seismic Rehabilitation of Existing Buildings* and *ASCE 41: Seismic Upgrade of Existing Buildings.* With that, they were very welcoming to us, waived us through and wished us well.

After getting to the hotel, we dropped off our luggage and began to return emails. We had heard that access to the Central Business District, where the most significant damage had occurred, had become very limited to nonessential personnel over the past week. So we were a little concerned that we would not be able to get into the cordoned-off area and observe the damage up close. But as it turned out Matthew ended up sitting next to someone from a firm that I had been in contact with because they had been so helpful to us on our October trip. That gentleman was very excited we were there because their firm uses ASCE 41 extensively in their practice. I received an email from him directing us to contact a gentleman named Paul at the Emergency Operation Center, who would arrange access to the CBD for us.

Courtesy Robert Pekelnicky

We got a hold of Paul, who told us to come by the Arts Centre (where the EOC has been set up) so we could fill out the paperwork and get our safety briefing. So we set out from our hotel walking across the main park to the west of the CBD. Our first observation was the amount of liquefaction in the park. There was the remnants of ejected sand all over. Light posts were tilted. The walking paths were very uneven. It was quite a sight.

Once we exited the park, we started to see damaged buildings on the outskirts of the CBD. One of the first big ones that caught our eye was a large red-brick unreinforced masonry building with large scaffolding up in front of it. Several walls had failed out-of-plane, ejecting brick into the street below.

Another brick building was next to catch our attention. This one had a large portion of the scaffolding along its side damaged. It appeared that the scaffolding had been put up to repair the building after the September earthquake, but did not fare well in this earthquake.

We then walked by and saw a gray stone masonry church that was severely damaged with a mangled nest of metal in front of it that was presumably scaffolding at one point.

After walking around the past of the western edge of the cordoned area, we arrived at the Arts Centre to meet with Paul. He was very welcoming, took us to fill out paperwork, and then sat us down to go over the safety rules inside the red zone. We were told that we would have urban search and rescue-trained firefighters with us while we were inside. There are a great number of buildings that have yellow tags, but are still rather unstable, in addition to those with red tags. The interesting thing was that a number of buildings received red tags, not because they were damaged, but because the building next to them had been damaged so severely that it presented a very real possibility of falling on that building.

Courtesy Robert Pekelnicky

Once we wrapped up at the EOC, we headed back to the hotel to get some lunch. It was now near enough to check-in time that we were all able to finally get our rooms. We settled in quickly, then went and got some lunch. Following that, everyone came back to take a couple hours to shower and unwind. We then wrapped up the night by having dinner with SEI President Roberto Leon, who's been in Christchurch since before the earthquake. He shared with us his firsthand account of the city right after the earthquake (which you can read in his journal online). We all had a great dinner and returned to the hotel VERY ready for bed (3 hours of sleep in about 48 hours is a little draining), and eager for everything that we feel we will learn over the next four days.

Day 2 – Tuesday, April 5

Our day started off at the Arts Centre, which is the Emergency Operation Center. Our contact, Paul, was busy in meetings so we ended up sitting around for about an hour. There were two ladies at an espresso machine making wonderful and free lattes, which made the wait very easy to bear. Paul got out of his meeting and delivered the bad news that our escorts had been co-opted by some business owners. Because there are still a great number of unstable buildings in the "red zone" – the area of the Central Business District that was most damaged – we cannot enter the cordoned area without a fire/life safety escort. However, today Civil Defense was letting business owners into the red zone to retrieve belongings, but with an escort (including the ones arranged for us).

As gracious as Paul had been thus far, he stepped it up another notch by offering to drive us around the red zone since we were without escort and it was raining quite heavily. We all hopped into a van he obtained the keys for and headed out to the perimeter of the cordoned area. We got up to a checkpoint where we all had to present the passes we had been issued the day before to gain entrance.

I've been to a few major earthquakes before with ASCE/SEI teams. The first was to Chile and the second was to New Zealand after the September earthquake. In both cases, the cities were very different than I assumed they would be. When you see pictures from an earthquake on the news, they only show the devastated buildings and other infrastructure. They don't focus much on everything that is undamaged or only moderately damaged. So to go there and see something damaged but surrounded by a number of undamaged things changes your perspective. This was NOT the case as we entered the red zone.

The devastation was everywhere I looked. This is what I pictured a major disaster area like. There were scores of partially collapsed buildings, nothing but crushed cars lining the streets, with the only people in site being the police and army who were stationed to keep out looters and squatters.

Courtesy Robert Pekelnicky

Driving through the red zone, we came to the first building that we could do a September-February comparison of – The Oxford Terrace Baptist Church. It was a large, one story unreinforced masonry church. In September, the shanking had caused its front to begin to pull away. That was shored up by some steel braces when we got there in October. Today, however, the church was mostly a pile of rubble.

We drove by another old church, St. Paul's. It is an 1880's unreinforced masonry church that suffered some damaged in September. That damage was some moderate cracking of the URM walls, but there was no threat of collapse. As with Oxford Terrace, unfortunately, this church has completely collapsed.

Courtesy Robert Pekelnicky

After September quake Oxford Terrace Baptist Church After February quake

While driving around, Paul explained to us that they designated certain buidlings in the red zone as indicator buildings. Those are select buildings representative of the typical buildings in the area. The indicator buildings were photographed extensively after the earthquake and then again after each subsequent aftershock. The idea is to get a sense for the stability of buildings by understanding how the indicator buildings are responding to aftershocks. If an indicator buildings shows a substantial change or collapses after an aftershock, then that alerts everyone to the potential hazard contained in all that buildings that one building represents and the areas around those types of buildings should be evacuated.

Courtesy Robert Pekelnicky

After September quake St Paul's church After February quake

After our tour of the red zone, we headed south east to Lyttelton, a small town that was very close to the epicenter. The town is basically shut down. The several block area where all the shops are was partially closed off. Any restaurants or shops that were not in buildings that were damaged, were themselves closed down. So our lunch plans were stalled as we had to head back toward Christchurch to find somewhere to eat.

Courtesy Robert Pekelnicky

Following lunch we headed north to Dallington and Kaiapoi. We wanted to look at some of buildings and pedestrian bridges that we observed in October. First we went past St. Paul's Catholic Church in Dallington, which is not the same St. Paul's in the red zone. In September, a lateral spread of the ground caused by liquefaction ripped the one story wood church apart. When we got there, we only found a vacant lot. It appears the church had been torn down.

We then went on to see a pedestrian bridge over the Avon River which was damaged in September and further damaged in February.

We then went to the Kaiapoi Train Station, which had rotated significantly due to liquefaction in Septmber. It appeared to have rotated even more in February.

Following that, we drove back to Christchurch and walked around the outer edge of the red zone. After that, we called it a night and headed back to the hotel for dinner. While waiting for dinner we talked a little more about how amazed we were at how widespread the damage was in the Central Business District.

Day 3 – Wednesday, April 6

We arrived at the Emergency Operations Center just before 8 a.m. so that we could attend the start of the day briefing with the engineers, firefighters and other life safety personnel. We were acknowledged as being in the room and henceforth known as "the Americans." There are a number of engineers set up to do Level 2 assessments and two members of our team – Brian and Charlene – will be tagging along with two of those engineers.

New Zealand has a document similar to our ATC-20: Post-Earthquake Safety Evaluation of Buildings, which has multiple levels of investigation. Level 1 is a very cursory, walk-around-the-building type assessment. Level 2 is a more detailed assessment, but still conceptual in nature, where an engineer goes though the building and offers their judgment about the safety of the building. The building is then assigned a red, yellow or green placard. Green means the building is fine, while red means the building is highly unsafe. Yellow means the building is unsafe, but limited entry for brief periods by persons familiar with damaged buildings is permitted. Almost all the red zone within the Central Business District (CBD) has been tagged yellow or red. Even if they were fine themselves, many buildings were tagged red because they were in the fall zone of a red-tagged building.

The remainder of our team – Owen, Matthew, and myself – was allowed to walk around the red zone with one caveat. We had to have fire/life safety escorts. So we were assigned two wonderfully helpful firefighters to escort us. We were allowed unrestricted access within the cordoned area, even within the fall zone of the red-tagged buildings. There was only one caveat – we were not allowed to enter red placarded buildings, unless accompanied by a New Zealand Chartered Professional Structural Engineer.

We were permitted to enter yellow-placarded buildings. However, if we did the firefighters had to notify the EOC that we were entering a building. Also, only one of the firefighters was to follow us in the building. The other was to stand outside in case something happened, like an aftershock. Fortunately, none did!

As we walked through the CBD, we were amazed not only by the level of building damage, but also the amount of liquefaction. There was not a street or sidewalk within the CBD that did not have some sign of liquefaction. There was everything from minor cracking of the pavement to full-blown sinkholes in the street.

As we walked around, we saw the Grand Chancellor hotel. A three-block radius around this building had been closed off due to fears that the building could fall. There were some failures in the concrete shear walls which led one side of the building to drop a reported 750mm (about 30 inches). The building just stands there ominously, leaning up to 10 degrees at some points.

Courtesy Robert Pekelnicky

We came across two buildings that we had observed in October at 223 and 225 High Streets. It appeared 223 High had a minor upgrade done to it, presumably at one-third of code. On the other hand, 225 had a brand-new upgrade done to it at 100 percent of current code. The parapet in the rear of 223 High failed and there was some cracking in

Courtesy Robert Pekelnicky

the unreinforced masonry along the street-side face at the upper story. The 225 High building was undamaged. February's earthquake managed to knock down the parapet and large portions of the upper story wall in 223, while 225 again appeared undamaged. You could get up close to 223 and see how the bricks just pulled away from the adhesive anchors.

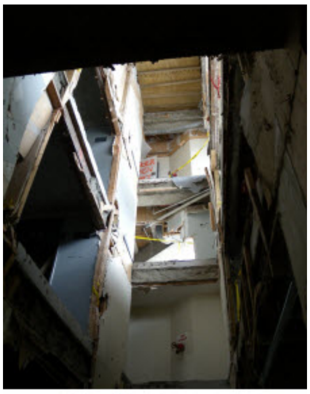
Courtesy Robert Pekelnicky

Continuing our walk, we came to a row of buildings along Manchester Street that had also previously been damaged. What appears to be a row of about six separate buildings is actually one building built in 1880, but divided into six separate shops by unreinforced masonry walls (URM). The building looks amazingly similar to what it looked like in October. It was at first a surprise, given how much more

Courtesy Robert Pekelnicky

intense the shaking had been in this more recent earthquake and how all the other buildings we'd looked at in both had performed. However when we got closer we could see that the building had been stabilized by adding some out-of-plane through bolts and horizontal wood whaler beams along the façade. While this would not aesthetically qualify as a permanent upgrade, it appeared to do the trick to strengthen the building such that the walls did not fall out into the street as they did at 223 High.

We spent the rest of the morning walking through the red zone and looking at a number of very interesting buildings, too many to describe here. We then went back to the EOC for lunch, where I was fortunate to run into an engineer whom I'd spoken with in October. We had a nice lunch together and I got to get some more information on how they thought buildings performed. Following that, we headed back into the red zone, with two new firefighter escorts.



Courtesy Robert Pekelnicky

The first building we went to was the Forsythe Barr building. It is a tall building that structurally performed well. However, there was one very serious issue with this building – the exit stairs collapsed! The exit stairs were precast concrete elements, meant to span from one floor to the next. They were situated on four-inch angles. That was not enough of a seat during the severe seismic shaking, and most of the stair elements unseated. They had to break windows and lift people out of the building.

Courtesy Robert Pekelnicky

We then looked at another building where one of the exterior columns had dropped due to soil liquefaction under it. There are a number of buildings in the red zone that are tilting due to liquefaction under their foundation.

One of the last buildings we reviewed was an apartment building with a café on the first floor. The building was a concrete shear wall building with some cracking in the core wall and some diagonal cracks in the coupling beams. But what made this building so unique for me was that it was the first time I got to don a P100 respirator. One of the ancillary consequences of the earthquake occurring around lunchtime is that everyone left their food where it was and got out of the CBD. Since then the CBD has been cordoned off. The main focus was fist rescuing people and then getting important office equipment like servers out and allowing residents to get stuff out of their homes. There

Courtesy Robert Pekelnicky

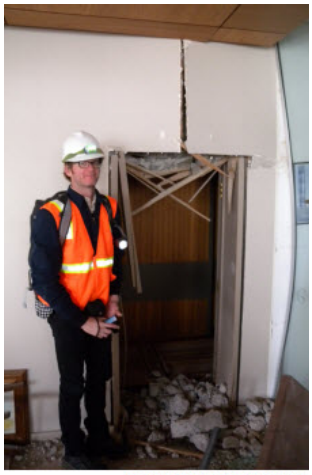
has not been a high emphasis placed on cleaning up anything else. So there was all the food that had been left since the people got up and ran out of the building **six weeks ago**! You could imagine how rank the smell was – hence the need to don a respirator.

We wrapped up the day back at the EOC where they had an engineers' briefing on the situation inside the red zone and steps moving forward for engineers to get into the CBD to perform assessment they've been contracted to do for their clients. Following that there were some presentations on various aspects of the earthquake. The ASCE/TCLEE team was also there and following the briefing we dined with them, along with SEI President Roberto Leon.

Day 4 – Thursday, April 7

Today was the team's last full day in Christchurch. We all depart to Auckland tomorrow at varying times and then head from Auckland to San Francisco on the same flight. But if it's true that you save the best for last, today was no exception! We were escorted into several red-placarded buildings today by representatives of one of the highest regarded New Zealand structural engineering firms.

In the morning we were taken around the city by one of its top Urban Search and Rescue engineers, and shown some of the more spectacularly damaged buildings. We saw one building, the Copthorne Hotel, which had severe beam and column damage because there were shear walls atop them that did not continue to the basement. Apparently, New Zealand had the same issues U.S. engineers did with discontinuous shear walls; only in the past 20 years are they beginning to adequately address this and steer engineers away from their use.



Courtesy Robert Pekelnicky

The next building we looked at was a concrete wall and frame building where the shear wall core settled differentially with respect to the rest of the building, due to the underlying soil liquefying. Here is Owen Rosenboom standing next to a door opening in the core wall that originally was probably about 7 feet tall, but has shrunk to less than 6 feet.

After leaving that building, we walked over to the tallest building in Christchurch – the Grand Chancellor. We were all excited to be able to go in and see the damage in this building. A load-bearing wall and two columns supporting a large transfer girder had failed, causing the southeast corner of the building to drop about 3 feet. The building was so noticeably leaning that emergency crews cordoned off a radius of about 4 blocks around the building. The

Courtesy Robert Pekelnicky

failed wall and columns had been encased in an inordinate amount of concrete to strengthen and stabilize them. It was amazing to see how much the floors had dropped. The floors in the picture should be flat.

After walking through the Grand Chancellor, we broke for lunch.

After lunch, we met up with another engineer from the Holmes group who was going to take us into three buildings this afternoon. We first headed to Clarendon Tower. It's a tall building in which the stairs had dislodged and there were some failures in the floor diaphragm. In fact, there was such a severe failure where the precast double-t sections actually dislodged from the beams and are being help up solely by adhesion to the 2-inch topping slab which is spanning like a catenary. Unfortunately, it was not safe for us to go up to the floor under that to observe. However, we did get some very sobering pictures of the failed stairs. Being in this building and the Grand Chancellor were probably the two most unnerving points of the trip.

Courtesy Robert Pekelnicky

We then walked over to the Christchurch Cathedral. We were very lucky to find out that the engineer taking us around was going to be the one designing the repairs to the cathedral. They had previously upgraded the cathedral by adding some shotcrete to the front face and then strengthening the roof diaphragm.

At the time they were not permitted to do any work in the spire, which in my opinion was unfortunate, because that is what collapsed. The remainder of the cathedral was damaged, but according to that engineer, it was essentially what their complex nonlinear models had predicted would happen.

Courtesy Robert Pekelnicky

Following the cathedral, we had the opportunity to walk through another tall concrete shear wall building. That building had some damage to the wall and also to the floor diaphragm. In September, cracking was found in the floor diaphragm topping slab. The Holmes Group then began an upgrade of adding FRP sheets to the floor. The FRP appeared to have performed well and there were no additional or wider cracks observed in the floor.

This has been an amazing trip. We've learned a great deal and have several observations that we will be taking back to incorporate into ASCE 31 and 41. What has been most amazing is how receptive the New Zealand engineers have all been to us. It turns out they hold our standards in high regard and want nothing more than to be a part in helping to improve them. They see the value in understanding what happened in this great tragedy and moving forward from it with better provisions for everyone to use. Several engineers have actually volunteered to become members of our standards committee. We're all very grateful for their help this week and the collaboration that this event and the one in September have forged.

ΣΕΙΣΜΟΣ ΤΟΗΟΚU ΙΑΠΩΝΙΑΣ

Στις παρακάτω ιστοσελίδες μπορείτε να βρείτε φωτογραφίες και video των καταστροφών που προκάλεσε ο σεισμός και το tsunami της 11ης Μαρτίου 2011 στην βορειοανατολική Ιαπωνία.

http://www.abc.net.au/news/events/japan-quake-2011/beforeafter.htm

http://www.nytimes.com/interactive/2011/03/13/world/asia/satellite-photos-japan-before-and-after-tsunami.html?hp%3Fsrc=ISMR_HP_LO_MST_FB

http://www.universetoday.com/84042/satellite-photos-before-and-after-of-japans-earthquake-tsunami/

http://www.abc.net.au/news/events/japan-quake-2011/gallery.htm

http://www.abc.net.au/news/video/2011/03/14/3163304.htm

http://bradblogspeed.com/tsunami-from-ground-zero (video of tall buildings in Tokyo swaying during the earthquake and comments on building code)

ΣΕΙΣΜΟΤΕΚΤΟΝΙΚΑ

GLOBAL ERTHQUAKE MODEL (GEM) in the wake of the M=9 Tohoku, Japan, earthquake

The Japan Catastrophe

Each time a severe quake shakes the earth, we are struck by the power of mother nature, we are sad for the people affected, but are at the same time reminded again of the importance of this effort we are undertaking together. We need to learn more about the earth and its behaviour, and how that impacts us humans. Global knowledge sharing and collaboration is therefore of utmost importance. The only way to develop better models and tools, is to compare notes and learn from each other. We need to have open discussion and debates, so that collectively we improve our knowledge on earthquake hazard and risk and come up with tools that are able to capture that growing body of knowledge and support mitigation activities. We can then test the tools and models together, compare them with national and regional models, with existing tools, and improve where possible. So it is important to have (more of) Japan's excellent scientists involved, just as much as experts from Chile, New Zealand, the US and China, to name only a few countries. For now however, we wish our Japanese colleagues and collaborators the strength they need to get through this difficult period, and to be able to rebuild what was lost.

The 11 March 2011 M=9.0 Tohoku earthquake struck on a subduction zone along the Japan Trench that had not experienced an earthquake of this size in Japan's long 1200-year history. Its closest forerunner was the smaller Jogon shock that struck offshore Sendai in AD 869. And so history was misleading, as it can be in so many other countries with even shorter records and slower tectonic processes. Surely, this is a problem common to all attempts to forecast seismic shaking and prepare for disasters, and should cause all of us to reassess how we estimate the maximum size and frequency of earthquakes on hazardous faults.

During the recent past, not only Japan, but also California, China, and New Zealand have suffered large damaging earthquakes on heretofore unknown faults, on faults far from the major plate boundaries, or on faults thought to be incapable of producing earthquakes of such magnitude, underscoring that this is a problem that few countries have escaped. Perhaps the best way forward will be to depend less on the record of any one subduction zone, but by instead pooling earthquake records from all subduction zones to generalize their behaviour. The same approach could be taken for continental transform faults and many other plate boundaries and fault systems.

Each country has its own approach to hazard and risk assessment, conditioned on its earthquake history and paleoseismic record, seismic catalogue, fault inventory or lack of one, its strain data, and most important, its scientific bias and software tools. Certainly many countries have the resources and scientific expertise to build their own hazard and risk models, but none of these national models can be tested in less than 50 years, few of them can be easily inter-compared, and all will suffer from inadequate records of past events, and so we will be unable to fully learn from or improve upon these models if they remain in isolation.

To advance this enterprise, we need a set of open tools to explore alternatives, we need a trans-national dialogue to discuss and vet our different ideas and approaches, and we need to conduct prospective tests of global models that are based on these various national strategies. Only through a shared standard set of tools will we be able to exchange ideas, results, and approaches, and only through such global testing will we learn what methods are superior.

The best and surest way to learn what approaches can better assess future earthquake occurrence is to build a common vocabulary and a common set of exploration tools, and to come together as a global community and openly exchange and test competing ideas. GEM was founded to do just that, and we welcome the world to join us.

Ross Stein Chair Scientific Board GEM Foundation **Anselm Smolka** Chair Governing Board GEM Foundation **Rui Pinho** Secretary General GEM Foundation

Μετακινήθηκε ο βυθός της Ιαπωνίας

Σύμφωνα με έκθεση της ιαπωνικής ακτοφυλακής, ο βυθός κοντά στο επίκεντρο του σεισμού της 11ης Μαρτίου μετακινήθηκε περίπου 24 μέτρα ανατολικά-νοτιοανατολικά και υψώθηκε κατά περίπου 3 μέτρα.

Ο μεγέθους 9 βαθμών σεισμός "χτύπησε" σε βάθος 24 χιλιομέτρων, δήλωσε η Μετεωρολογική Υπηρεσία.

Η μετακίνηση του φλοιού μετρήθηκε σε απόσταση περίπου 130 χιλιομέτρων από την χερσόνησο Οσίκα στο νομό Μιγιάγκι, στη βορειοανατολική Ιαπωνία.

Η μετακίνηση του βυθού ήταν τέσσερις φορές μεγαλύτερη από εκείνη της ίδιας της χερσονήσου - ανατολικά-νοτιοανατολικά κατά 5,3 μέτρα - σύμφωνα με τη Γεωδιαστημική Αρχή Πληροφόρησης της Ιαπωνίας.

Ένα σημείο περίπου 40 χιλιόμετρα προς την ακτή από το επίκεντρο μετακινήθηκε περίπου 15 μέτρα ανατολικά-νοτιοανατολικά, μετέδωσε το πρακτορείο Kyodo News επικαλούμενο την έκθεση αυτή.

TSUNAMI

Japan needs better tsunami infrastructure

More infrastructure spending by Japan could have lessened the impact of this month's deadly tsunami but the government has become too reliant on low-cost measures such as handing out warning maps, a prominent tsunami researcher said.

Japan should invoke Western-style urban planning to keep houses and hospitals further from the coast as it rebuilds from the crippling disaster, said Fumihiko Imamura, a professsor at Tohoku University's Disaster Control Research Center.

Japan's cash-strapped government has moved away in recent years from costly projects such as increasing the height of sea walls to budget measures like producing maps that show which areas are at lower sea levels, he said.

"We cooperate with the government on tsunami countermeasures, but there has been less financing and sometimes there isn't enough for the construction of structural measures," Imamura said in an interview on Sunday.

"Now, the government's focus has shifted to non-structural measures, because they are cheaper."

Imamura, a scientist who has been studying tsunami for nearly 30 years, uses computer models based on historical data to predict the speed and size of the deadly waves caused by earthquakes.

The tsunami that savaged Japan's northeast coast on March 11 was one of the largest in recorded history and far bigger than anything anticipated by scientists because they did not expect such a massive earthquake, he said.

The disaster killed more than 10,000 in the world's third-biggest economy and nearly 17,500 are missing.

The waves were so big that they destroyed several of the tidal gauges used to measure wave size. The tsunami itself lasted as long as two days, as its waves reached as far as Chile before being reflected back to Japan, he said.

As one of the world's most earthquake-prone countries, Japan is at the forefront of developing measures to lessen the impact of the waves, but more needs to be done.

The government should plant more pine and mangrove trees along the coast to slow down a tsunami, and build more evacuation centres that can withstand the waves, Imamura said.

He also believes that Japan should better plan for disasters when rebuilding ravaged towns.

One of the world's most densely populated countries, even Japan's rural towns and villages often seem cramped, with a handful of houses crimped together near the coast.

"We are living very close to the coast. The fishing industry needs to be near the coast, but living areas and other facilities need to be farther in," Imamura said.

"We need land-use planning."

(David Dolan and Mark Chisholm, REUTERS, March 27, 2011)

Japan's 60-foot tsunami toppled four-story concrete building, shattering safety and engineering strategies

ONAGAWA, Japan -- Oregon State University tsunami expert Harry Yeh thought he'd seen every kind of damage a giant wave could inflict, until a sight in this devastated fishing town stopped him cold.

Here amid crushed cars and mangled houses, a four-story reinforced-concrete building rests on its side like a toppled domino, knocked over by the March 11 tsunami that soared 60 feet high. Yeh says the fate of this building upends the global science of tsunami preparation and evacuation.

Yeh has visited virtually every tsunami zone from Nicaragua in 1992 to the Indian Ocean in 2004. He believes the failure of the Onagawa structure, which housed living quarters above a CD music store, will cause revised recommendations for construction and escape strategies on the Oregon coast and other tsunami-prone areas. Yeh and Steven Kramer, a University of Washington earthquake expert who traveled to Japan with him last week, say the Northwest could be far better prepared.

THE OREGONIAN

"Up to now, we thought reinforced-concrete buildings were safe," Yeh said. "So we recommended to people that if they don't have time to escape a tsunami, find a reinforced-concrete building and climb up to the fourth floor."

Japan is widely considered the best prepared nation in the world for tsunamis and earthquakes. It emerged largely unscathed from the magnitude-9 quake that triggered last month's tsunami.

Yet the monster waves that left more than 28,000 dead or missing shattered not just cities but estimates of the outer bounds of destruction. Scientists, engineers and architects examining apocalyptic damage along miles of Japanese coastline are recalculating the enormous power of water set in motion by quakes.

Residents of Onagawa, a fishing port east of Sendai, Japan, say the tsunami appeared on the horizon like a vast dome of water spanning the bay. The giant wave roared into town, devouring ships, houses and everything else in its path. Then the water retreated, sucking cars from elevated parking lots and depositing some atop buildings. More towering waves followed.

"There were people who went up to the tops of three- and four-story buildings," said Hiroshiko Oka, a bar owner who watched from a hilltop shrine. "They got killed."

Oka, 52, watched bank employees emerge on the roof of their three-story office building, scaling a rooftop stair enclosure one floor higher. But the tsunami crested the building, pitching a dozen people -- some of them Oka's childhood friends -- to their deaths. One survived.

Oka, whose tavern behind another tipped-over building was demolished, said it was the tsunami's first monster wave that knocked over structures, including the reinforced-concrete building that Yeh considers so significant.

A cell-phone video recorded by a local medical worker shows people who reached the roof of a nearby five-story building surviving the tsunami. That building did not tip over.

Yeh pointed out that many reinforced-concrete buildings in Japan's tsunami zone remain standing. He said lots of people were saved by "vertical evacuations" to floors above the tsunami, which reached widely varying heights at different points along the coast. So the unexpected failure of one building doesn't necessarily negate all advice on tsunami preparation and survival.

But Yeh remains troubled by the toppled building. He's stunned, even with all he has seen of past tsunamis, by the massive scale of damage in Japan. "The Sendai plain, it's so vast it's just incredible," he said, referring to a devastated expanse in the tsunami zone. "I'd never seen this type of site before. I was totally, totally stunned."

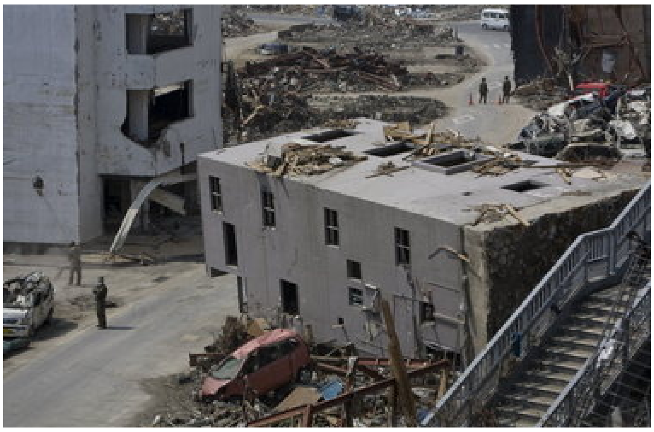
"Then I saw this Onagawa site," Yeh said, referring to the city with the overturned building. "This is just incredible."

The toppled edifice made Yeh think of reinforced-concrete buildings -- or rather, the absence of such structures -- on Oregon's coast. The Seaside parking garage is one. The five-level structure has interior shear walls with seismic reinforcement. Coastal communities should consider reinforced-concrete buildings in new construction, especially for public structures, Yeh said.

Yeh studies flow-structure interactions and tsunami-induced scour. He plans to research ways of preventing buildings from tipping over.

Yeh's colleague from Seattle, the UW's Kramer, said tsunami-hazard awareness and evacuation planning have improved along the Oregon and Washington coasts, especially since the 2004 Indian Ocean tsunami, which killed 230,000 in 14 countries.

"Still," Kramer said, "after seeing tsunami debris hanging on the sides of hills some 60 feet over my head -- and cars on top of four-story buildings -- in Onagawa, I doubt that the general public is fully aware of just how bad things can get."



Japanese troops clean up and monitor traffic Friday around a four-story building knocked over by the March 11 tsunami in Onagawa, Japan. Oregon State University expert Harry Yeh says the building's unexpected failure upends standard and advice and precautions concerning tsunamis.

As an earthquake expert, Kramer said the key question is why the magnitude-9 quake did such little damage. He said Japan's numerous seismometers have yielded the best-ever picture of ground shaking and where it occurred. The ground shook longer and harder than the 1995 quake in Kobe, Japan, which collapsed 200,000 buildings and an expressway, killing more than 6,000.

Japanese building codes and earthquake awareness are partly responsible for the lack of damage, but there are structures built well before code improvements that performed relatively well, Kramer said.

"If it wasn't for the tsunami," Kramer said, "I think the Japanese would be considering the damage of this earthquake to be a great success story."

Kramer said the Northwest could be far better prepared for earthquakes, let alone tsunamis.

"The Northwest is much less prepared than California, and California is much less prepared than Japan," he said. "Part of that is human nature -- the Japanese are reminded that they live in earthquake country all the time, and we aren't," Kramer said. "Their governments and private firms have also been willing to invest in earthquake-resistant infrastructure and earthquake preparedness. Ours haven't."

Kramer and Yeh traveled Japan's northeast coast with other U.S. experts on a mission to guide larger U.S. teams expected to arrive here shortly. They visited Tokyo, Ichinoseki and the devastated coastal cities of Onagawa, Sendai, Kesennuma and Rikuzentakata.

Yeh said Oregon's geography resembles northeast Japan, with many isolated coastal communities separated by a mountain range from a valley with highways. Like Japan, Oregon faces an undersea subduction zone, in which an oceanic plate pushes beneath a continental plate. Japan's offshore trench is far deeper.

"We do not know what kind of rupture process we're going to have" for that Cascadia zone, Yeh said.

Yeh worked previously on nuclear power-plant engineering. He said the Fukushima Daiichi nuclear complex hit by the tsunami and leaking radiation is a product of old technology. "Forty years ago, they did the best they could do," he said. "This tsunami was beyond the predictions."

Nuclear plants could be located away from tsunami zones by storing cooling water on higher ground, Yeh said, instead of using a once-through ocean coolant system. Earthquakes would still be an issue, he said, but not tsunamis.

Yeh, 61, has Chinese and Japanese ancestry. He grew up in Japan and speaks Japanese. He said he became emotional at times last week, touring the tsunami zone.

"The Japanese will probably rebound from this event," Yeh said. "They've done it before, from the war."

"If this is successful, this can be a model for the entire world."

(Richard Read / The Oregonian, Saturday, April 16, 2011)

Tsunami's Incredible Force Evident Quickly

The first of as many as seven ASCE reconnaissance teams to investigate the damage caused by the March 11 earthquake and tsunami arrived in Japan on April 15. Led by structural engineer Gary Chock, P.E., S.E., M.ASCE, president of the Honolulu-based practice Martin & Chock, the first team is documenting the performance of buildings and other structures not addressed by other teams. The team is concentrating on Miyagi and Iwate prefectures, with a focus on how what they learn can be incorporated into the tsunami structural design provisions under development for the next revision of the ASCE 7 standard, Minimum Design Standards for Buildings and Other Structures. In this daily diary, Chock details the team's activities and shares photos of what they observed.

Day 1 -- Saturday, April 16

Courtesy Gary Chock

The first group of the ASCE Tsunami Reconnaissance Team (Ian Robertson, David Kriebel, Iaon Nistor, and me) met with researchers associated with Dr. Tomoya Shibayama of Waseda University (Dr. Hiroshi Takagi of the Tokyo Institute of Technology plus Dr. Hideyuki Kasano and Dr. Miguel Esteban of Waseda University) for a coordinating discussion, including some observations from the Japanese research teams that have been visiting all affected coastal areas except for Fukushima prefecture.

Thereafter, we flew to Misawa Airport in northern Honshu. Our field work will be following a north to south strategy. Our flight kept us out of the United States-designated 50-mile exclusion zone around the heavily damaged Fukushima Daiichi nuclear power plant.

In Hachinohe, we started to encounter tsunami effects at the ferry and fishing ports. Here, the tsunami's height had been eight meters above sea level. There were a number of fishing vessels that had been lifted onto the wharf, as seen in the photo above.

On Tuesday, we will proceed down to Tarou and Miyako City.

Day 2 -- Sunday, April 17

Today's route has taken us from Kuji City down to Miyako City, and on this southward route we've begun to encounter the most severely damaged areas.

Courtesy Gary Chock

The outer protective tsunami defense wall at Tarou City was reduced to rubble.

At Kuji port, the tsunami-defensive seawalls -- more than nine meters high -- were overtopped. The overland surge damaged light-framed construction in the neighboring commercial area, and also blew out a heavy steel gate through the tsunami containment wall of the port from its rear and dislodged it by more than 60 meters.

South of Kuji, the tsunami damage increased dramatically. The town of Noda had a 15-meter-tall tsunami defensive wall. However, the tsunami runup height was 30 meters high. As a result, destruction of the town was nearly total. One is struck in awe when viewing tsunami damage and debris found nearly 100 feet above the nominal sea level.

The tsunami defensive wall for the town of Fudai was much more successful in mitigating the effects of a 18.5-meter tsunami water depth. Even though the gated wall was overtopped by about three meters, the extent of damage on the lee of the wall was greatly reduced and damage to the town was minimal.

The seaside cove hotel of Ragaso was subjected to a 20-meter tsunami and experienced much flooding and non-structural damage; even so, this multi-story steel and concrete building appears to be repairable.

The town of Tarou experienced a tsunami higher than any in their recorded history, with a runup height of roughly as high as 20 meters. Tarou had a unique "X" patterned seawall that compartmentalized portions of the town. Unfortunately, all sections of the walls were overtopped, and the town is at least 75 percent destroyed.

In the town of Miyako we examined areas of the town outside of the seawall and the portions within. The difference was remarkable, with the unprotected area essentially 90 percent destroyed, and the portion behind the seawall severely damage, but largely localized. This was in spite of the fact that various sections of the protective wall were overtopped by about two meters.

In summary, the tsunami's height was greatly affected by the coastal bathymetry and local topography, and in all

Courtesy Gary Chock

An evacuation sign lies among the debris of a Miyako City home, outside of the seawall.

cases so far exceeded the design height of tsunami defensive walls and gates. The damage was most severe to low-lying communities. There are now extremely large debris piles as high as 10 meters in the heavily damaged areas.

Day 3 -- Monday, April 18

Courtesy Gary Chock

The tsunami's force flipped a masonry-walled dormitory in Otsuchi onto its side.

We have been staying overnight at inland hotels, because any in the coastal areas, if they remain in operation, are booked by response personnel or relocated residents. Our route to examine Otuschi and Kamaishi thus started from Morioka. The drive to the coast included a mountain pass with snow and several simple country farming towns. During this time, at least in my opinion, one can't help but develop a further appreciation of an underlying elegant expression of Japanese lifestyle. What you notice is the concept that anything undertaken should always be done with the best effort and utmost precision of execution. When everyone does this, a harmonious mechanism results where everything appears to be just where it ought to be. In public works that would normally be mundane back home in the U.S., extra attention is paid to human-scaled details with aesthetic design qualities. Also in keeping with polite respect of others, there appears to be a remarkable lack of graffiti, litter, or spiteful vandalism.

Our arrival in the tsunami-stricken area of Otsuchi Bay was therefore quite shocking, because in the span of a few seconds, or less than a few hundred meters, the serenity of the scene is utterly transformed into chaos; there is extremely little middle ground between the unaffected and severely damaged zones.

An outlying large community of Otsuchi Bay, like most of the coastal communities, was protected by a seawall that was overtopped by a tsunami surge that was roughly twice its height. Any light-frame wood construction was destroyed down to the foundation, except at the very edge of the tsunami inundation. Every community has tsunami road signs indicating when you enter and leave the potential tsunami inundation zone. These signs appear to have been reasonably located, as the destructive part of the tsunami occurred within the zone. Therefore, it seems that those responsible for tsunami evacuation and awareness policy implementation for public safety did not assume that tsunami effects would always be prevented by these seawalls.

Otsuchi City itself included numerous larger low-rise steel-frame, reinforced concrete, and masonry structures. Debris in the tsunami flow accumulated quite rapidly once the surge encountered structures, and it piled up against the downstream buildings and infrastructure. Not all of these remained structurally intact. In fact, there were examples of yielded steel frames and collapses of steel buildings, some of which affected neighboring buildings. We took detailed dimensional measurement of several of these for later analysis. Towards the port industrial area, we discovered several masonry-bearing-wall dormitory apartment buildings that had overturned and rolled on their side, or flipped. We also found a large tour boat catamaran that ended up perched on top of a two-story concrete building.

Courtesy Gary Chock

Steel-framed buildings like this three-story structure were still no match for the tsunami.

Irrespective of size, the majority of coastal communities along most of the areas we visited had been provided with seawalls designed for tsunami mitigation. The tsunami protection walls mainly consisted of either earth-fill dikes protected by concrete slabs on both the offshore and onshore slopes, or of massive gravity seawalls constructed of monolithic unreinforced concrete. However, with essentially no exceptions, seawalls were overtopped, subsequently creating a breaching failure. Undermining failures have also occurred due to massive scour of the onshore toe of the sea wall, another consequence of overtopping. In other cases, some concrete gravity seawalls were overturned by the return flow after inundation, rather than by the incoming tsunami. Seawalls were equipped with heavy steel gates and the majority of these gates seem to have resisted well the incoming flow, but not necessarily the outward return flow.

The port city of Kamaishi was an important stop for us because we had seen a video showing the surge flow over a low seawall, impacting several buildings of many different orientations, heights, and construction materials. We took measurements to confirm inundation depth of the flow and examined the internal structural configuration of a key dormitory (Kaikan) building that affected the flow downstream.

While in these areas, crews were working on drilling and setting new precast concrete power distribution poles along the road. This was moving quite efficiently with special truck-mounted drilling and crane rigs supported right behind by low-bed tractor-trailers bringing up a supply of poles. Work is occurring everywhere to remove debris and restore essential services, and well as to provide living accommodations for tsunami survivors.

Day 4 -- Tuesday, April 19

The weather has taken a turn to near freezing temperatures with rain. From Ichinoseki we traveled to Kesennuma and Rikuzentakata.

At Kesennuma, we examined the main shipyard and designated tsunami shelter buildings. We were able to view a video of the incoming surge affecting the port area that was taken from this tsunami vertical evacuation building. It had been inundated up to between the second and third floors.

Courtesy Gary Chock

Lifted and carried by the tsunami, a large ship smashed into Kesennuma Port.

We took detailed measurements of a two-story steel-framed building that was attacked in the transverse direction that quickly failed and was swept away. Fortunately, we found the building as well as its exposed foundation. There had been a quite significant loss of a portion of a pier in the vicinity, and it was quite interesting to see its tiebacks and their soldier pile anchorages exposed with the slab scoured away. Later, we observed a 165-feet-long vessel that had floated over the top of a 20-foot-high building and “t-boned” a smaller building before coming to rest amid several other structures.

Rikuzentakata had quite a lot of coastal buildings and bridges that exhibited clearly defined failure mechanisms. Again, rather than observational photos, we took detailed measurements of these elements as well as measurements of inundation depth at each. These case studies will provide some useful "full-scale" validation examples for loading equations that the Tsunami Loads and Effects committee will be able to consider for future inclusion in the ASCE 7 Standard.

The temperature hovered near freezing all day and our evening drive included light snowfall.

Day 5 -- Wednesday, April 20

From Kitakami we drove to Minamisanriku. The mountain pass we went through provided a beautiful display of snowfall on the forest from the night before. The moist snow hung on the tree branches like cherry blossoms, making the mountainside evoke an appearance of spring.

Minamisanriku was bleak and devasted, with only a few remaining buildings left standing. Only buildings on the hillside periphery remained. This has been a large community with a population of approximately 30,000, including a three-story emergency operations center. Although the center had been manned during the tsunami, it was completely inundated. Even after evacuating to the rooftop, many of the city’s emergency management staff were swept away.

Courtesy Gary Chock

Minamisanriku's emergency operations center had been manned for the tsunami, but it was inundated.

We also visited a local four-story reinforced concrete shear wall hospital that had been inundated on all floors except the roof. It was evident that patients had been moved there. At the hospital's entrance, someone had left a flower arrangement. A small group of people was there, talking quietly and occasionally.

Closer to the shoreline, a four-story reinforced concrete apartment building had served as a designated tsunami evacuation building, since it was one of the taller and more robust structures in the area. However, it had also been completely inundated just over the roof. Presently, it is nearly surrounded by water due to the erosion and settlement of the surrounding area. Evacuees on the roof apparently remained safe, as confirmed by one of our Japanese collaborators who had interviewed survivors during the prior weeks before our arrival, and there were still remnants of blankets and a small fire they had made for warmth during the evening after the tsunami.

We got a good look of the town overall from a hillside school that had been used for evacuation. The driveway leading up to the school was lined with trees now in bloom with cherry blossoms. A video taken from this spot was shown on television worldwide. That underrepresented the real extent of the damage of the town, mostly set in a broad coastal valley plain. The hill was quite far away from the shoreline, yet it was surrounded by destroyed homes. With a tsunami surge, distance means almost nothing; it's elevation that's the difference between whether you live or perish.

When there are any personal artifacts that are discovered among the ruins of a home, the Japanese carefully arranged them on a small clear area on the former homesite, and these items are not disturbed. One does not walk over a homesite even when totally destroyed, unless it cannot be avoided. We have walked past a great number of collections of recovered personal items during our trip, but out of respect I will not post any pictures. By now, I think there is no one left to retrieve those families' items. Some of what we saw were backpack bags used by children for primary school.

At another hill, a regional sports facility has been converted to a response and recovery center. Bustling with activity, it serves as a refugee housing facility as well as the central point for emergency response and recovery operations. Temporary buildings also had been erected, and this serves as a surrogate town center for survivors. Crews of specialty responders and medical personnel from many other prefectures are here. It was a very busy place. The workers and volunteers serving the survivors were trying to be as helpful and positive in tone as possible. The shelter has a sign entreating everyone to do their best.

Day 6 -- Thursday, April 21

Courtesy Gary Chock

In front of the foundation of an overturned building in Onagawa are, from left to right, ASCE reconnaissance team members David Kriebel, Gary Chock, Ioan Nistor, Ian Robertson, and Dr. Hiroshi Takagi of the Tokyo Institute of Technology.

The primary objective for today was the city of Onagawa, east of Sendai. Our Japanese collaborators had alerted us in an understated way that we would find this area interesting and useful for our purposes. I would like to note that our Japan Society of Civil Engineers (JSCE) collaborators, particularly Dr. Tomoya Shibayama of Waseda University and Dr. Hiroshi Takagi of the Japan Institute of Technology, have been especially helpful and have given us a lot of beneficial advice. On the first day of our arrival in Japan, they provided us with a briefing and presentation of their own recent reconnaissance visits to tsunami-stricken areas. They worked with us to provide hotel reservations coordinated with our itinerary locations, set up our rental vehicles, and have patiently and tirelessly accompanied us to assist us with a myriad of assistances including translations as needed. We normally are out in the field from 7 a.m. to 8 p.m., and at the end of each day they make sure that we have a wonderful meal of authentic Japanese cuisine.

We could not be more pleased with how JSCE has accommodated the ASCE team; we could not have accomplished half of what we done so far without their hospitality. They are absolutely outstanding in character and great representatives for their country.

Within a minute of our arrival in Onagawa, we knew this would be an exciting day of investigative opportunities. There were half a dozen reinforced concrete buildings that had been overturned and laterally shifted by tens of meters. Some of these had pile foundations that had been sheared off. In viewing these along with other failed structures like pedestrian overpasses, overturned bridge spans, light poles, and massive stone tablets, we realized that the flow velocity had been high for both inflow and the *return* flow. We also found several cases of reinforced concrete walls and steel-framed walls that had been blown out by fluid pressure. A lot of our work consisted of taking detailed measurements of structural dimensions and reinforcing of elements and building structural system information for subsequent case study analysis.

Onagawa was a community that did not have tsunami protective seawalls; it only had offshore breakwaters for storm waves but these have now been obliterated. The tsunami runup here was quite high at approximately 60 feet, so the inundation overtopped many buildings. Besides steel, concrete, and masonry building studies, David Kriebel of our team also performed a transect sampling survey of one of the steeper residential hillside areas to determine the statistical fragility curve of wood-framed homes as a function of inundation depth.

We followed the train tracks up from Onagawa Station (Eki) back into a valley that was very far from the shoreline. The valley was filled with debris and was flattened. We found train passenger cars that had been carried far from the tracks. One was smashed against a low-rise concrete building, and another was lifted up on top of a cemetery hill. In east Asia, it is customary for cemeteries to be placed on the side and top of a hill overlooking the town with a view towards the ocean. Thus, in many of the earlier communities we had visited, the cemeteries had been undamaged while overlooking total devastation. In this case, the train had been rolled up over the site, smashing ornate stone tablets at family gravesites along the way. It was a yet another demonstration of the power of the tsunami.

Courtesy Gary Chock

The tsunami's force carried a train car (seen from its underside) into an Onagawa cemetery on a hill.

I would add from viewing the remainder of the hill above the inundation height that the family gravesites had stone tablets, Buddha statuary, and engraved family's clan crests (Mon) that were extremely refined and impressive displays of respect. While leaving the site, a family arrived with flowers and other offering items and walked under the perched train car on their way to their family's site.

Day 7 -- Friday, April 22

Courtesy Gary Chock

Seen from a distance, in Natori, cranes stack up a massive, ever-growing pile of trucked-in debris.

We are now staying in Sendai, and the Natori coastal plain region to the south of us appeared to be the affected area that was captured on video by NHK News helicopters as the tsunami arrived. Here, the tsunami surge became a broken bore due to the offshore bathymetry, and footage of the bore flowing across farmlands was seen worldwide. Today's reconnaissance was to examine surviving buildings identified in subsequent aerial photography. Today, we also met up with Tom Sawyer, senior editor of Engineering News-Record in New York, who will be accompanying us for a few days. [Click to view his blog entries.] The weather was wet with constant light rain and cold, but not freezing.

Natori was bustling, with a lot of truck traffic hauling debris to a massive pile near the coast. There were at least eight mobile cranes taking debris from a continuous stream of trucks and building up the huge pile.

After various detours around controlled intersections, we finally reached the low-rise reinforced concrete buildings we had seen in the aerial images. Several were nearly identical in construction, being of a system of precast concrete bearing walls. The end bay of one of the buildings had a collapsed bearing wall, another an upper floor failure due to a debris strike by a car, and the third had deep undermining due to scouring flow from the corners of the end bay wall. Thus the collection constituted three out of the four principal tsunami effects of hydrodynamic pressure, debris impact, and scouring effects (the fourth being hydrostatic fluid effects).

Courtesy Gary Chock

Team member Ian Robertson studies damage to a precast concrete-bearing-wall building in Natori.

We visited two hills in Natori that appeared to have been designated as tsunami evacuation hills, but found that each had been overtopped by a tsunami bore that was approximately 35 feet high or more near the coast. At one hill, we found a historical stone tablet engraved in archaic Japanese that warned of the potential for a tsunami following earthquake ground shaking, mentioning the Sanriku tsunami of 1933 that killed at least 3,000. Later, we found a modern metal sign (laying smashed on the ground) that also warned that any earthquake would be followed by a tsunami, and pointing inland. Unfortunately, in Natori, the low coastal plain stretches inland for miles. In March's tsunami, many were caught while trying to flee in their vehicles.

We visited one such site that had appeared in NHK video. To validate analysis of the video, we measured some key distances to waypoints along the tsunami's path that could be seen in the video. We also saw a site where some lives had been lost while in their cars. Nearby, we saw some personal effects by the roadside that probably had belonged to town residents.

Near the end of the day, we spent several hours at the Sendai Port Container Yard, documenting several container strikes on structures. A three-foot-diameter steel light pole about 50 feet tall was part of one such structure that had collapsed. As usual, we kept at our observations until the waning minutes of daylight. As we departed the port area, we noticed two trailer trucks smashed sideways against a metal building and an electrical utility pole. We will return to this site tomorrow.

Day 8 -- Saturday, April 23

Courtesy Gary Chock

At Sendai's port area, the tsunami's force threw a truck into a steel-framed industrial building.

We started the day with a return to Sendai port to examine some trucks that had been swept against a one-story industrial building and a nearby reinforced concrete utility pole. We have an interest in tsunami-borne debris impacts on structures, as well as debris accumulation in increasing the effective projected solid area of a building for hydrodynamic forces. As case studies to quantify the force, we need to collect data on the debris object and its effect on a structure.

While measuring the dimensions of the first truck, the point of impact on the steel corner column of the roof, and the inundation mud line in the building, the company's manager appeared. People were busy with clearing up debris that impeded the road and their business. Mr. Shishido, the manager, explained that after the initial tsunami wave, he ran about a kilometer and a half to high ground at a construction site and watched as the larger second incoming surge swept into his company's area. The truck in question had been across the street in the neighboring building's parking area. Dr. Shusaku Inoue of Takenaka Corporation, another of our local collaborators, explained our purpose and Mr. Shishido was quite agreeable to our investigation. He will be finding out whether the security camera on his building captured anything useful from the tsunami. When we had finished, he brought a bag of iced coffee drinks (exactly two for each of us.) Noticing that he had been wearing a monogrammed golf cap that was a little old, we gave him a new ASCE-monogrammed navy blue baseball-style (basubaru) cap as a reciprocal gesture.

Courtesy Gary Chock

Another tossed truck at Sendai's port rests against a concrete utility pole it had snapped into pieces.

At truck number two, Dr. Mogi of Saitama University explained our mission to the debris clearing road crew. We then proceeded to take necessary measurements of the second lateral strike, which had shattered the power pole at the point of impact and yielded its base. The pole was of the spun-cast hollow concrete type with longitudinal reinforcing made of steel wires, which is typical in Japan. The pole had a diagonal strut of a reinforced concrete pipe as well. I would expect that this truck and the power pole will be removed within a matter of days.

The port area had a large sports facility and a hill for viewing the area, which we visited to determine whether it had been overtopped (in this case, no.) We took inundation depth data from this hill. In the surrounding area, there were a number of signs of various sizes and supports that had been bent over by the tsunami, and we took measurements of these items for analysis of minimum flow velocity.

Courtesy Gary Chock

The tsunami's force bent and snapped a row of flagpoles at the entrance to a sports complex.

Tom Sawyer of ENR was very quick to pick up on what we were looking for, and he made a remarkable find of a series of flag poles that had been laid down by the tsunami, in front of the sports building that had an extremely clear mudline indicating maximum water depth. None of the poles had debris strike marks of any significance, and a few had been split open, permitting us to take wall thickness dimensions. This allowed us to acquire a nice data point with water depth, flow direction, with the information required to compute flow velocity.

From the hillside, we saw at the port an extremely large commercial shipping vessel against the side of a failed mobile crane and building. After checking in with port security, we were allowed to visit this site. What we surmised was that the ship had been raised during the inflow, and then ridden up on the dock during outflow. It had crushed a very robust tower crane, then smashed in the corner of the neighboring building and bent its forward prow bulb, then pulled away from the building during a subsequent inflow.

Courtesy Gary Chock

A major shipping vessel had been lifted onto the dock, wrecking a cargo-handling tower crane and adjacent building. For a sense of scale, Dr. Mogi of Saitama University held up a five-meter pole.

Later in the day, we went back to Onagawa to sketch up some steel-framed building failures and give Sawyer an opportunity to view the variety of building failure modes in both inflow and outflow conditions. It was a good chance to discuss fluid hydrodynamics and hydrostatics. While walking among the ruins, we found a nice bent-over steel pole-mounted sign that served as another good surrogate "instrument" for estimating minimum outflow velocity. It had been protected from the inflow by a building but had failed during outflow. As I mentioned in a previous post, we saw a lot of evidence of high outflow velocities. As usual, it wasn't until after dark when we returned to our hotel.

Day 9 -- Sunday, April 24

Today is a transitional day for the ASCE Tohoku Tsunami Reconnaissance Team. Due to the severity and great extent of tsunami damage in Japan, we had decided to split our team into an initial group (including myself, Ian Robertson, Ioan Nistor, and David Kriebel) traveling the coast from the northern most town of Misawa down to Natori south of Sendai over the past eight days, and a follow-up group (Daniel Cox, Mathew Francis, and Solomon Yim) spending an additional six days examining areas that the first group did not have a chance to see or study in detail due to time limitations. The tsunami team's two-phase approach gives us an initial sweep through the area and a follow-up sweep of areas identified on the ground rather than by remote sensing, as well as data fill-in for areas that were not possible to fit in the daylight hours we had available. The Dan Cox group will continue the team's work, giving us two full weeks of observation time. Today, we gave them a briefing on our findings and identified the recommended focus areas for their itinerary.

The ASCE Tohoku Tsunami Reconnaissance Team does not have just an overall damage assessment objective. Through aerial and satellite photography, we had identified key areas of damage that were the starting points of our investigation on the ground. A priori remote sensing can detect overall status, i.e., complete or partial collapses of buildings, seawalls, breakwaters, and bridges, but it does not show the performance and deformations of individual structural members, nor failures that are not open to sky. Boots on-the-ground investigations are essential to discover and record detailed information on exact mechanisms of failures and the inundation water depth at the local site. For the tsunami team, discovery of a noteworthy structure and photography is just the beginning. We take dimensional measurements of the governing structural mechanisms being induced by the tsunami as well as overall dimensions of the structure, so that a structural analysis can be re-created. Local water depth is also noted whenever possible. For near-collapse structural components, samples of bolts, concrete and reinforcing steel may be taken for testing.

We also look for what we have termed "velocity surrogate" structures nearby, such as a sign, light or power pole, or other isolated simple structure that has been significantly deformed by the flow alone, and not debris strike. We measure the velocity surrogate structures with equal attention to detail, so that we can calculate the lower bound velocity of the flow impacting the main structure of interest. If such velocity surrogate structures are undamaged and are of a standardized design (such as a utility pole) that can also serve as an upper bound measure of velocity.

Along Japan's Tohoku coast, there is more damage than what a reconnaissance team could document in detail even if it stayed for months rather than weeks. However, the rapidity of debris clean-up and structural demolition puts a limit on how much time is available to collect the most useful data. We are basically on a race against the demolition crews to capture evidence. Working hours for this team generally started at 7 a.m. with our return to lodging scheduled for after nightfall, with stops of no longer than 15 minutes for eating during the day. Obviously, for tsunami-related investigations, time is of the essence, and ideally they should always be conducted as soon as roadways are initially cleared during the first phase of a country's disaster response.

We have complied with a travel restriction set by ASCE for us to remain outside of the U.S.-designated 50 mile/80 kilometer exclusion zone around heavily damaged, radiation-leaking Fukushima Nuclear Power Plant No. 1. Thus, there are about 100 miles or 160 kilometers of coastline that we have not seen, starting just south of Sendai Airport down to northern Ibaraki Prefecture (Kitaibaraki). In addition, Thermo Fisher Scientific donated a number of electronic personal dosimeters for each member of the reconnaissance team, so we have been able to monitor exposure while in Japan.

The cumulative dose we have recorded while here in Aomori, Iwate, Miyagi Prefectures and Tokyo has been exceedingly low. We have received about the equivalent of a digital dental X-ray visit while here, or the equivalent of the two nighttime flights from Tokyo to Honolulu, during which airline passengers are subject to greater background cosmic radiation from being higher in the atmosphere. Put another way, international and U.S. protective action guidelines typically call for evacuation of the general public for an equivalent annual dosage of 2,000 millirem. We have received less than two millirem in Japan during a week and a half of mostly being out in the open. Thus, we have no concern for our personal safety related to radiation effects. In fact, airline flight crews will have accumulated more nominal radiation than we will have over the same period of time. I would point out that we were aware of this before our arrival, since Japan publishes radiation data for stations throughout the country. The Thermo Fisher Scientific meters have been quite reassuring nonetheless, so it is prudent for the other teams to utilize them, however utterly bored they may become with the output data. I would suggest that future teams literally be given more latitude to study a greater portion of Fukushima Prefecture based on a radius established by the radiation monitoring data (and of course not less than that set by Japan for its own public). The meters also have alarms for doses and dose-rates that can be preset for real time monitoring.

Before Dan Cox arrived, we had about a couple of hours to wait, so we scooted down to the Natori River that had been videographed with an initial smaller broken bore. The speed of a broken bore on still water is considered a classic hydraulic jump analogy taken from the frame of reference of the bore tip, and its speed is related to the Stillwater depth and the height of the bore. We measured the depth of the river and the height and length of some riverbank protective concrete facing that was designed as alternating horizontally and vertically patterned segments of a repeated dimensional length. The video clearly showed the bore edge changing as it encountered each segment pattern, and so with this exercise we have a metronome for the speed of the bore and the parameters needed to validate the equation.

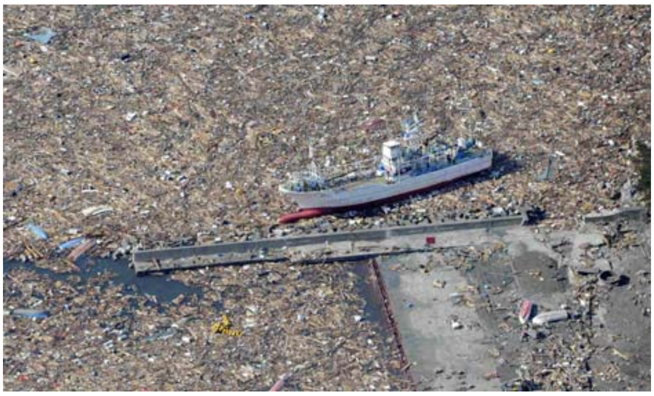
This field reconnaissance will help resolve some key questions in the ASCE tsunami design provisions regarding flow velocities and momentum of tsunami surges over land, debris flow, debris strike effects, erosion and scouring, as well as gain information on overarching questions on risk-based design criteria and the ultimate capabilities of structures to resist a maximum credible tsunami.

On Monday, April 25, we have a debrief session at Waseda University with Dr. Shibayama. Today, we drove across from Sendai to Sakata on the Japan Sea to fly back to Tokyo. This involved a two-and-a-half-hour drive over snow-covered mountain passes that was quite scenic. We filled our gas tank in Sakata near the Shonai Airport; our gas station attendant/owner was a nice middle-aged Japanese woman who asked us where we had been and then remarked that everyone coming from there arrived with dirty cars. We also agreed that the conditions were very severe (taihen desu).

When we arrived at the airport rental car return, we were an hour earlier than our booked car reservation period. The Toyota rental car staff member was an extremely polite young woman who apologized for the delay while she processed us a credit rebate for the one hour less equivalent cost of our rental. When we presented our reservation papers, she always asked if she could handle them before she even touched them, and presented our credit receipts with both hands. We could not be allowed to leave with any overcharge whatsoever and were thanked for our patience. Always doing things correctly and precisely with politeness and courtesy towards the customer or guest is so important in Japan.

Japanese culture has so many good lessons for anyone to learn about gracious and polite personal conduct, humility and respect for others, and doing the utmost in the performance of responsibilities. It is a great country with an unbroken spirit, and I hope for their best in recovering from such an unprecedented natural disaster.

Τα πλοία βγήκαν στην στεριά …



και τα αεροπλάνα στους δρόμους …

ΣΥΜΠΕΡΙΦΟΡΑ ΓΑΙΟΚΑΤΑΣΚΕΥΩΝ

Resiliency Impresses Geo-Institute Team

A team from the Embankment, Dams and Slopes (EDS) Committee of the Geo-Institute arrived in Japan on April 23 for a one-week engineering reconnaissance of the region affected by the Tohoku Japan earthquake. The three-person team is led by Joseph Wartman, Ph.D., P.E., M.ASCE, of the University of Washington, and includes Binod Tiwari, M. ASCE, of California State University, Fullerton, and Daniel E. Pradel, Ph.D., P.E., D.GE, F.ASCE, of Praad Geotechnical Inc. and the University of California, Los Angeles. The EDS /GI team is being hosted by Professor Keizo Ugai, president of the Japanese Landslide Society and an instructor at Gunma University. The team is also working with the Japanese Geotechnical Society. Team members will be posting updates to the ASCE web site throughout the week.

Days 1 and 2 -- Saturday, April 23 and Sunday, April 24

Report by Joseph Wartman

Our team has spent the last two days visiting the Fukushima region in the company of Profs. Ugai and Wakai of the Japanese Landslide Society and Gunma University. The Fukushima Prefecture is four hours north of Tokyo and about a hundred kilometers from the earthquake epicenter. Despite having suffered high levels of ground shaking (up to 0.7 g), there is surprisingly little damage to buildings and major structures such as bridges; earth structures such as embankments, levees, and retaining walls generally appear to have performed well in the areas we visited. We have been impressed with the resiliency of the transportation networks, which appear to be functioning at nearly full capacity. These observations very like reflect to some degree the stringent building codes used in Japan and the excellent quality of construction works.

We have visited several landslides — some very large — that have affected smaller secondary roads. The photo below is an example of one such landslide of at least several hundred square meters in area.

Courtesy Joseph Wartman

An earthquake-triggered landslide completely blocked this secondary road in Fukushima Prefecture.

Interestingly, some of the landslides we visited were reportedly triggered not by the main shock on March 11, but several weeks later by a shallow magnitude 7.0 earthquake thought to be related to the larger subduction event. This shallow earthquake resulted in about one meter of mostly vertical surface fault rupture several kilometers in length, as seen below. The fault rupture offset roads, drainage culverts, and at some isolated located, buildings.

Courtesy Joseph Wartman

A 7.0 magnitude aftershock created a fault rupture several kilometers long.

We will be continuing north from here to the Sendai region in the coming days.

(ASCE, 29th April 2011)

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ΦΑΙΝΟΜΕΝΑ ΡΕΥΣΤΟΠΟΙΗΣΗΣ

Quake Bogs Down a Tokyo Suburb

URAYASU, Japan—More than a month after the devastating earthquake hit northern Japan, hundreds of residents in an upscale bedroom community near Tokyo still don't have functioning plumbing, causing the city's mayor to lash out at the national and prefectural governments for not responding quickly enough.

Urayasu, a 20-minute train ride away from Tokyo Station, is akin to Westchester County in New York: close enough to the city to commute daily, but far enough away so people can afford to buy more-spacious homes.

Soil liquefaction pushed manholes out of the ground in Urayasu.

But when the earthquake struck on March 11, the city, which is also home to Tokyo Disneyland, quickly sank into the ground and became submerged in mud, partly because 75% of it sits on reclaimed land. Tens of thousands of residents in this city with a population of 165,000 were deprived of water and natural gas for weeks following the quake. Tilted houses, warped roads and popped-up manholes are now strewn across the dust-covered city. As of Wednesday, about 140 households remain without running water in Chiba prefecture, while nearly 300 households in Urayasu are unable to shower or flush toilets due to broken or clogged sewage pipes.

Located about 190 miles south of the earthquake's epicenter, Urayasu was spared the tsunami but much of the wreckage was caused by soil liquefaction, which occurs when soil loses its strength because of an applied stress such as a temblor. The stress can be exacerbated in soft-clay soils and landfill areas.

No deaths were reported from the earthquake in Urayasu, where no apartment buildings collapsed. Tokyo Disneyland, which has been closed since the earthquake due to parking-lot damage and power shortages, is set to reopen Friday.

Experts said another anticipated fallout from the liquefaction is a decline in Urayasu's property prices.

The road to full recovery will be long. In the immediate aftermath of the disaster, much of the electricity, gas and water were cut off in many districts across Chiba prefecture. Civil engineers said the magnitude of the quake, measuring 9.0, and repeated aftershocks accelerated the spread of liquefaction.

Susumu Yasuda, a professor at Tokyo Denki University, said that codes for sewage systems that address liquefaction were introduced in Japan only in 1981, which left older reclaimed land areas such as Urayasi—where the first construction began in 1964—vulnerable.

(Kana Inagaki / The Wall Street Journal ASIA, 14 April 2011)

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Tokyo Bay Home Demand to Drop as Quake Turned Land to Mud, Shattered Pipes

While most of Tokyo avoided major damage in the March 11 quake because of stringent building codes, in some parts of Tokyo Bay the magnitude-9 temblor triggered liquefaction, a phenomenon where soil loses its strength after violent shaking. The most affected suburb was Urayasu, one of only three residential areas in greater Tokyo where land prices rose last year, and the home of the Tokyo Disneyland resort.

Quicksand

Liquefaction, which causes soil to act like quicksand, was found across about 86 percent of Urayasu's surface land, said the local council's Sekine. About 112 kilometers (70 miles) of road in the 17 square-kilometer (7 square-mile) city were damaged, she said.

In the 1995 Kobe earthquake, liquefaction caused many buildings to lean, particularly around the port area of the city 311 miles west of Tokyo on the southern side of Japan's main Honshu island, said Yasuo Tanaka, a geotechnical engineering professor at Kobe University. Tougher regulations in Tokyo since then helped prevent failures on solid ground in last month's temblor, he said.

Reclaimed land in Urayasu, which makes up three-quarters of the area, was built of mud and sand over 15 years through 1980. The area may be reinforced by inserting pipes to extract water, installing steel piles, or pouring in concrete, Tanaka said.

The last major earthquake to strike Tokyo and its environs directly was in 1923, when more than 140,000 people were killed, according to the Cabinet Office. The last major one, with an 8.4 magnitude, was in 1854.

'Different Story'

Tokyo's population of about 13 million is adjacent to three major fault lines, including the Nankai Trough, which produces a large quake every 118.8 years on average, according to the Headquarters for Earthquake Research Promotion.

The March 11 quake triggered a tsunami with waves as high as 15 meters (49 feet) that damaged or destroyed more than 200,000 buildings and leveled towns in Japan's northeast.

"If it was just an earthquake, things would probably go back to normal," said Mikihisa Hirai, president of Atlas Partners Japan Ltd., which owns more than 2,000 apartments in Nagoya, Osaka and Tokyo and who predicts a drop in waterfront property prices. "With the tsunami, it's a different story. What's more of a concern is that with seashore properties, there is nowhere to escape."

(Kathleen Chu and Mariko Ishikawa - Apr 14, 2011)

Tokyo Disneyland's Parking Lot Turned Swamp Shows Risk of Reclaimed Land

The district surrounding Tokyo Disneyland may have to reinforce reclaimed land housing 96,000 people after last week's magnitude-9 earthquake turned the ground to mud, snapping utility pipes and tipping buildings.

The quake triggered ground liquefaction, which causes soil to act like quicksand, across much of the 1,455 hectares (3,600 acres) of reclaimed land in Urayasu city, said Kazuhisa Nakatani, a local government spokesman. Some of Disneyland's parking lot was also affected, trapping as many as 30 cars. The main park areas didn't suffer as they sit on 15-meter (49-foot) deep reinforced foundations.

"There's no question the earthquake damaged the area more than expected," said Yasuhiko Hino, the head of urban disaster prevention projects at the Ministry of Land, Infrastructure, Transport and Tourism. Houses in the suburban district were most affected as they lack the concrete pilings that protected high-rise buildings, he said.

A car drives past a crack in the road from the recent earthquake in Urayasu.

Urayasu may consider reinforcing the reclaimed land, which makes up about three-quarters of its surface area, once it has finished dealing with emergency repairs following the March 11 earthquake, Nakatani said. At least one more runway at Tokyo's Haneda Airport may also be strengthened to bolster defenses following the March 11 quake, the fifth largest ever recorded.

"I was very surprised there was land damage to an area like Urayasu, so far from the seismic center of the quake," said Yasuo Tanaka, a professor of geotechnical engineering at Kobe University. "They should have been prepared for earthquakes, but given the damage, it clearly wasn't enough."

Urayasu may consider reinforcing the reclaimed land, which makes up about three-quarters of its surface area, once it has finished dealing with emergency repairs following the March 11 earthquake.

Kobe Quake

Ground liquefaction caused many buildings to lean over in the 1995 Kobe quake, particularly around the port area, he said. Toughened regulations since then helped prevent failures on solid ground in last week's temblor, he said.

The reclaimed land in Urayasu was built of mud and sand in the 15 years ended 1980. Reinforcing work could entail inserting pipes to extract water, installing steel piles or pouring in concrete, said Tanaka. Concrete would be the most expensive option, he said.

Any reinforcement work would require "a huge budget," said Urayasu's Nakatani. The city, bordering the eastern edge of Tokyo, is about 400 miles from the epicenter of the quake. The temblor and a subsequent tsunami may have killed more than 20,000 people in Japan's northeastern Tohoku region, based on government figures.

Haneda Airport

All four of the runways at Haneda, Asia's second-busiest airport, were built on reclaimed land. None was damaged by the quake. At least one of the two unreinforced strips may be strengthened, said Keitaro Samizo, assistant to the head of the transport ministry's aviation-planning division.

Tokyo's Odaiba Island, home to Fuji Media Holdings Inc. (4676)'s headquarters, is also built on reclaimed land and experienced liquefaction, according to Minoru Saito, a spokesman for the Tokyo Metropolitan Government's Disaster Prevention division. No damage to utility pipes or other facilities that would disrupt residents' lives occurred, he said. While the city has disclosed areas that are prone to liquefaction, it has no plans to conduct any large-scale land fortification, he said.

The last major earthquake to strike Tokyo and its environs directly was in 1923, when more than 140,000 people were killed. The city of about 13 million is adjacent to three major fault lines, including the Nankai Trough, which produces a large quake every 118.8 years on average. The last one, with a magnitude of 8.4, was in 1854.

Power Shortages

Repair work on Disneyland's car parks is almost finished, said Hiroshi Kitamura, a spokesman for operator Oriental Land Co. The park, which opened in 1983, has been closed since the temblor as Tokyo battles power shortages and transport disruption.

A Sapporo Holdings Ltd. (2501) beer-processing plant in Funabashi, near Urayasu, damaged in the quake also remains shut, spokesman Tatsuya Komatsu said today.

Shigeyuki Nishinoyama, 54, who lives on the second floor of a six-story block in Urayasu with his wife, said that the quake caused part of his building's parking lot to collapse. There were no gas supplies until yesterday and the main waterpipe is still broken, leaving the couple without running water, he said.

Nishinoyama said he was warned about the risk of liquefaction when he bought the house and he has no plans to leave the area. "I like the community and feel even closer to them after this ordeal," he said.

(Makiko Kitamura and Maki Shiraki / Bloomberg, Mar 23, 2011)

ΣΥΜΠΕΡΙΦΟΡΑ ΜΝΗΜΕΙΩΝ

Japan ICOMOS National Committee

Flash Report on the Situation of Damage on Cultural Properties and Buildings, Scenery and Historic Sites

Notice from Kazuyuki Yano, Secretary General, JAPAN ICOMOS National Committee Damages of National Properties Caused by Earthquake

The 1st Immediate Report, 2011/03/22

A huge earthquake with magnitude of 9.0 hit North Eastern side of Japan at 2 : 46pm on March eleventh, 2011. Caused by this disaster, a lot of people and properties were lost or damaged, as well as many cultural properties.

I appreciate all the care and words of encouragement by colleagues from ICOMOS. I would like to announce we did not have any colleagues of JAPAN ICOMOS found lost or missing fortunately. However, more than 20,000 people could be lost or missing in total caused by earthquake and Tsunami this time. This is considered to be one of the largest natural disasters in Japan.

Most of victims are from Tsunami, not by an earthquake. We had Tsunami so many times in the past, as "Tsunami" came from Japanese word, some people might have wondered why the damage was so devastating this time. The earthquake was the biggest one in history after we had measuring system for earthquake, and Tsunami was much bigger than people's prediction; some of Tsunami was over 10~15 meter, or even 20 meter.

Agency for Cultural Affairs is now working for collecting all the information regarding the damages of cultural properties, but it is still unclear. So far we found that almost 240 properties were damaged, that are limited to designed or registered property by nation. The number could increase from twice to three times if including designed properties by local government and unregistered properties.

Severely damaged properties, as in collapsing ones, are just a few in all the damaged properties we found so far. Most of damages are miner as in cracks on walls or damaged roofing tiles.

On the other part, famous "Matsushima", one of the three representative sceneries in Japan, were severely damaged by Tsunami, and there were a few collapsed properties (though repairable).

We do not have major damages as many as when Han-shin Awaji Earthquake hit Japan 16 years ago. The reason could be because of difference in earthquake frequency. However, damaged properties are spread in a wide range (700km in north and south×100-200km in east and west). Although most of the damages are minor, number are so many.

"Shrines and Temples of Nikko", one of the world heritages, are found not much damaged, and "Hiraizumi,-Temples, Gardens and Archaeological Sites representing the Buddhist Pure Land" currently on a tentative list, did not get major damages either.

We can easily imagine that we are going to encounter a lot of problems for recovery process. For now, we would like to make all the effort to collect information and to analyze them. Based on the Agency of Cultural Affairs' information, we would like to report it once it's organized.

Lastly, crisis of a nuclear plant caused by Tsunami are being broadcasting all over the world, and people should be very worried about it. However, Tokyo has not been affected by radiation. We would like to continue normal activity.

Japan ICOMOS National Committee

Flash Report on the Situation of Damage on Cultural Properties and Buildings, Scenery and Historic Sites

Dr. Toshikazu Hanazato, Japan ICOMOS/ISCARSAH member, 2011/03/27

A. Overview of the Earthquake Disaster

Overall picture of the disaster of Tohoku Pacific Earthquake on March 11, 2011 has not been put together after 12 days. However, its characteristics are outlined as the followings:

1. Total number of human losses and missing caused by tsunami is about 23,000 as of March 22nd, and it could increase further.

2. Unlike Kobe in 1995, which was a devastating earthquake with a shallow focus directly underneath the metropolitan area causing the damage to concentrated area on the fault, this earthquake had an impact on a much broad range. It not only covers a massive area of Eastern Japan but also triggered nuclear disaster.

3. Most of the damaged areas of this 3.11 Earthquake has recently been experiencing great earthquakes of magnitude 7: Miyagiken-oki Earthquake of June 12, 1978 (M=7.4), Iwate Miyagi Nairiku Earthquake of June 14, 2008 (M=7.2), Chibaken-Toho-oki Earthquake of December 17, 1987 (M=6.7)

4. Most of the buildings were destroyed or washed out by tsunami and not much so by strong ground motions. Some traditional wooden buildings are reported to have collapsed but the percentage of collapsed houses due to strong motions is comparatively lower than Kobe Earthquake of M=7.3. This is due to the fact that the damaged areas had secured earthquake resistant capacity after experiencing recent large earthquakes (as shown on 3) of intensity scale X (Modified Mercalli Intensity Scale (MMI) corresponding to intensity scale 6 positive in Japan Meteorological Agency (JMA) Intensity Scale).

5. Damages were seen on reinforced concrete buildings built before the revision of regulations for seismic designs under Japan Building Code in 1981.

B. Features of earthquake ground motions

It was an interplate earthquake around plate boundary caused by subducting of Pacific Plate into North American Plate. Moment magnitude was 9.0, similar size to Sumatra Earthquake of December 26, 2004, and rupture area of the fault is estimated to be 500km X 200km (after NIED).

Areas that experienced the intensity scale of X or greater (MMI) spread out from Iwate prefecture to the northern part of Ibaraki prefecture. Strong ground motions of which acceleration level exceeded 0.5G were recorded at a number of seismogram stations in those wide area. Furthermore, acceleration level of ground motions at some sites was as high as 1.0G. However, according to spectral characteristics of strong motion records which recorded intensity scale of X or greater (after Earthquake Research Institute of the University of Tokyo), component of period 1-2 seconds (which has great impact on traditional wooden houses) was about 1/3 of the Kobe Earthquake of January 17, 1995. On the other hand, component with short period less than one second was predominate compared to the Kobe earthquake, which connotes that progressive failure is unlikely to happen for the traditional wooden buildings. Distant places from epicenter, such as Tokyo, were affected by the ground motions with longer period. Tokyo Tower, a cultural heritage structure constructed in 1958 with a height of 333m suffered the bending of its tip.

C. Situation of Damage on Cultural Properties and Buildings, Scenery and Historic Sites

Due to the Earthquake, damages on officially designated cultural sites were reported in areas greater than 600km from Aomoroi prefecture to Kanagawa prefecture. As of March 22, total damaged designated sites reported are about 296 but the number will increase as the site surveys proceed. Ever since the Kobe Earthquake of 1995, earthquake devastation on historical buildings has drawn increasing attention in Japan.

Therefore, after the Earthquake of 3.11, media reported damages on cultural sites immediately. Furthermore, "damaged buildings list" was also created in a few days by the Government, Agency for Cultural Affairs.

According to that list, most of the officially designated cultural sites averted major destructions. When excluding stone lanterns, mud-walled warehouses and gravestones, only two collapsed; one is Ibaraki University Goura Bunkazai Bijutsu Bunkazai Research Center Rokkakudou Hall (Ibaraki prefecture), lost in tsunami, and the other is Kyu Yuubikan (Miyagi prefecture), which recorded strongest intensity scale. One of the characteristics of this devastating Earthquake was a great magnitude with strong short period motions, as described in 2), which affected buildings with short natural period such as mud-walled warehouses. Most of the damage reported are cracks on mud-walls or on plaster finishing, descent of roof tiles, fractured glass windows and ceilings falling down. In particular, Non-structural elements of such roof tiles, windows and ceilings, faced destructions. Protected areas of important traditional buildings (Makabe, Sarkurakawa City, Ibaraki prefecture) also had damages on mud-walled/stone warehouses. Same situation can be seen in the traditional townscape area in Kiryu City, Gunma prefecture, where many of the registered cultural properties faced collapse of mud-walled houses and roof tops. Areas recording intensity scale greater than X (MMI) were not reported to have major destruction because they do not contain historically valuable masonry buildings. On the other hand, heritage of industrial modernization such as powerhouse aqueduct were listed for the damages on government registered civil structures.

However, data collecting for damages on cultural properties and buildings registered by prefecture and municipality level is still underway. Damages on unregistered historically/culturally valuable properties and historical townscape have not been grasped yet. Site survey to comprehend the overall disaster of the cultural heritages would be needed as early as possible, with the cooperation of Institute of Architecture and the other organizations.

Tsunami devastated Pacific coast in Tohoku area had beautiful rias, of which the 200km coastline was registered as a National Park. Cities and settlements situated along the coast have long history of disastrous tsunamis in the past; not many heritage structures remained in the area.

State registered special scenic beauty, Matsushima was also devastated with the Earthquake. Matsushima was known for its beautiful natural scenery of tiny islands floating in the bay but is now disrupted with the great tsunami. Matsushima is a compound of both natural and cultural beauty and luckily the cultural sites escaped great destructions; both Zuigan-ji Temple, a national treasure built in 1609, and an important cultural property, Godaidou Temple, eluded tsunami.

D. Supportive Activities for Reconstruction Operation on Damaged Cultural Properties, Townscape and Natural Scenery

The supportive operation underway is for emergency rescue and lifesaving. At the same time, more than 200,000 refugees require help for their lives. However, in the future reconstruction period, restoration of historic sites and scenery will also need to be considered. State, prefecture, or municipal registered sites will be protected by law. On the other hand, the unregistered historical buildings damaged are likely to be demolished and dismantled. In 1995 Kobe Earthquake, many historical buildings were classified "dangerous" in the quick inspection of damaged structures and were dismantled. Therefore, Hyogo prefecture established "Heritage Management Institution" to educate experts who can conserve historical buildings regardless of registration or non-registration to the state or prefecture. This institutional system is not yet introduced in the afflicted area of the Earthquake of 3.11. Current operation focuses on quick inspection of damaged structures for the wooden houses to cope with aftershocks but it needs to consider preserving historic sites and cultural scenery in the period of both restoration and emergency countermeasure. Japan ICOMOS decided on a policy to cooperate with ICORP and other international organizations to support restoration of damaged cultural properties, townscape and scenery and to correspond with international assistance and support.

E. Relating Information Websites

Agency for Cultural Affairs: Damages to cultural properties in the "2011 Tohoku - Pacific Ocean Earthquake" (As of March 24, 2011 at 5:00 am) http://www.bunka.go.jp/english/pdf/2011_Tohoku_ver5.pdf

Contact

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Damages in Japan caused by Earthquake

Dear colleagues

I must apologize for my long silence since the huge earthquake. I have got kind inquiry e-mails from some persons.

Thank you for your concern.

I have finished a series of graduation ceremonies and attended a small meeting for regeneration of commercial area of Beppu, a famous hot-spring town in Kyushu Island. In the western part of Japan everyone is going to work and going about their days. Even in Tokyo metropolitan area there are no big problems except planned outage. The disaster area is very large unparalleled in history, but the area is a part of Japanese islands elongated from north to south.

A lot of cultural properties were damaged in the devastated area. However important historic towns and villages have not been included in the area. In the national designated conservation areas the historic houses of Sawara, Chiba pref. was damaged due to the shock of the earthquake (not included in the tsunami-devastated area) but the damage might be recoverable.

One of the greatest cares at the moment is nuclear accident. We have been watching the situation of the nuclear power plant with bated breath.

Anyway it will be difficult we are going to continue our energy-consuming life. I think the philosophy of historic conservation will be more important through the reconstruction of our society.

Sincerely

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www.sawara-machinami.com/sinsai/sinsai.html

Matinami

Fukusin

Syoubundokanban

Fukusindozo

Kaneri

Syoubundo

Kadomise

Toukai

Gogan

Abuso

Onogawa

Syoujou

Uedaya

Mitoya

Kyutaku

ΣΥΝΕΠΕΙΕΣ - ΜΑΘΗΜΑΤΑ

Japan will cultivate creative reconstruction for disaster-hit region

It will not be enough to simply rebuild the battered regions of Japan after last month's earthquake and tsunami, construction experts say. Rebuilding will need to be done on much higher ground, farther from the sea, and the newly built cities will need to utilize more green energy. "We have to pursue creative reconstruction," says Jun Iio, a leader of the reconstruction group. "We can't just build homes where

they were before so that they can be destroyed by tsunami waves again."

Japan seeks foreign ideas, green energy in rebuilding

Debris sit atop what's left of a three-story building surrounded by rubble in the obliterated city of Minami-Sanriku, Japan. Reconstruction officials are calling for settlements to be built on high ground.

Japan must rely more on green energy to restore power to the vast areas devastated by a nuclear-reactor disaster, a massive earthquake and a tsunami that wiped out whole towns, leaders of a government reconstruction effort said this week.

Cities and houses need to be rebuilt on high ground and to withstand the shocks from future earthquakes like the magnitude 9 temblor that rattled northeastern Japan on March 11, they warned. Authorities have recovered more than 14,500 bodies, and many fear the death toll will reach more than 25,000.

"It's not enough to restore things as before," said Jun Iio, one of the leaders of the reconstruction group.

"We have to pursue creative reconstruction. We can't just build homes where they were before so that they can be destroyed by tsunami waves again."

Mr. Iio, who is with the National Graduate Institute of Policy Studies in Japan, and the panel's chairman, Makoto Iokibe, president of the National Defense Academy, outlined plans to rebuild Japan in a briefing with foreign reporters in Tokyo.

Mr. Iokibe, a well-known historian, noted that Japan has always rebuilt and thrived after a crisis.

"We have to hit rock bottom before we can spring back stronger," he said.

Members of the panel - which includes respected philosophers, architects and corporate leaders - already have begun discussing the possibility of building alternative energy sources in the disaster zones, including solar, wind and geothermal power.

"Many people in our group feel very strongly that we must use more environmentally friendly sources of energy. We are very positive about this," Mr. Iio said.

The tsunami destroyed the cooling system of a nuclear power plant in Fukushima province, causing fuel rods to overheat and releasing vast amounts of radiation.

Mr. Iio predicted the recovery will take longer than the 10-year reconstruction of Kobe in southern Japan after a 6.9 magnitude earthquake that killed 5,500 in 1995.

"I think we will not even be finished after 10 years," he said.

"It's not enough to restore things as before. We have to pursue creative reconstruction. We can't just build homes where they were before so that they can be destroyed by tsunami waves again."

Mr. Iio said new buildings must be constructed on "very high ground" to protect from future tsunamis. The one spawned by the latest earthquake sent 30-foot-high waves crashing ashore.

He also suggested planting trees and making parks out of piles of wreckage and urged that each village or town form its own "reconstruction company," headed by the mayor.

Mr. Iio said the disaster is "of an enormous scale beyond the capabilities of Japan."

"We open our doors to different ideas from other countries," he said, inviting foreign help.

"We can use this disaster and reconstruction efforts as a means to combine our strengths and push Japan in a more positive direction. We need to receive more ideas and wisdom from around the world to do this," Mr. Iio said.

(Christopher Johnson / The Washington Times, Thursday, April 28, 2011 στο ASCE SmartBrief April 29, 2011)

Ιαπωνική Αποτελεσματικότητα

Η εικόνα των ρηγμάτων στον Ιαπωνικό αυτοκινητόδρομο δείχνει τη σφοδρότητα του σεισμού της 11ης Μαρτίου.

Οι εργασίες στον αυτοκινητόδρομο άρχισαν στις 17 Μαρτίου και **έξι ημέρες αργότερα** ο αυτοκινητόδρομος ήταν σαν καινούργιος.

CЅ ƐO

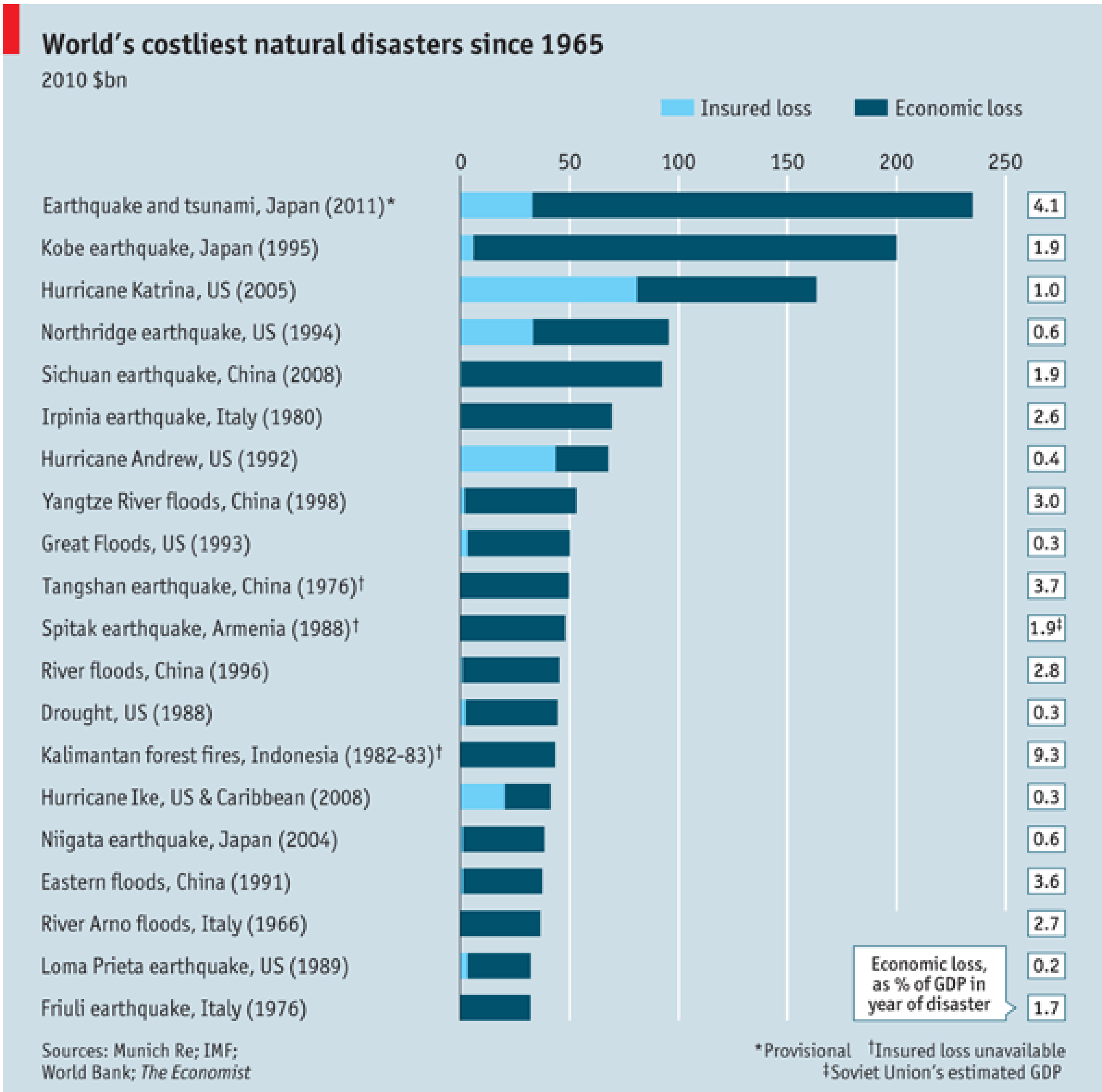
ΟΙΚΟΝΟΜΙΚΑ

Counting the cost

The Japanese earthquake could be the costliest disaster ever

JAPAN is still reeling from the earthquake and tsunami that struck its north-east coast on March 11th, with the government struggling to contain a nuclear disaster and around 10,000 people still unaccounted for. Provisional estimates released today by the World Bank put the economic damage resulting from the disaster at as much as $235 billion, around 4% of GDP. That figure would make this disaster the costliest since comparable records began in 1965. The Indian Ocean tsunami in 2004, which caused some 250,000 deaths, does not feature on this chart. Economic losses there amounted to only $14 billion in today's prices, partly because of low property and land values in the affected areas.

(The Economist online, Mar 21st 2011)



ΕΕΕΕΓΜ
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