Lessons from the Postearthquake Safety Evaluation in the 2010-2011 Canterbury, New Zealand Earthquakes and Implications for Updating ATC-20

Presentation at the 14th U.S.-Japan Workshop on the Improvement of Structural Design and Construction Practices

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Outline of Presentation

• Purpose and scope of ATC reconnaissance trip to Christchurch and subsequent report

• Useful ideas and practices

• Postearthquake safety evaluation and program management issues

• Research needs

• Guideline/training needs and potential updates to ATC-20

• Issues to be resolved
ATC Reconnaissance Trip

• Purpose: Learn from New Zealand experiences with postearthquake safety evaluation, on a technical and program implementation level, as a starting point for a potential update of ATC-20

• Team
  • Bret Lizundia, Rutherford + Chekene & ATC President at the time
  • Ron Gallagher, R.P. Gallagher & Associates
  • Jim Barnes, California Emergency Management Agency

• Dates: 26 June 2011 to 2 July 2011

• Scope
  • Reviewed damaged areas
  • Met with a wide range of evaluation participants
  • Spoke at structural engineers mtg on ATC-52-4
  • Presented findings to NZ federal government
Comparison of Approaches

- Current Standards
  - US: 2005 ATC-20-1 (Second Edition) Field Manual is most recent update
  - NZ: 2009 Guidelines (2010 draft was not used in the 2010-11 earthquakes)

- Both use red, yellow, and green tags
- Both have three levels of evaluation
  - US: Rapid, Detailed, and Engineering
  - NZ: Rapid Level 1, Rapid Level 2, and Detailed
Useful Ideas/Good Practices

- Use of triage
- Indicator buildings
- Shipping containers as barricades
- Private engineers provided safety evaluations as well
- USAR personnel as safety escorts
- On-call locksmiths
Useful Ideas/Good Practices

• High priority on evaluating shopping centers, drug stores and hardware stores

• Specific task force concept for targeted safety assessments for shops, suburbs, critical buildings, cordonling, and demolition

• Shelter-in-place strategies
  • Portable showers
  • Portable toilets
  • Temporary water lines

Image Credit: Christchurch City Council
Useful Ideas/Good Practices

• CBD cording and dynamic management

• Land management zonation program
  • Targets repairs where most cost effective
  • Aids in mitigating damage in future earthquakes

• Use of internet and social media for information updates
### Useful Ideas and Good Practices

- **Introduction of Usability Categories**

<table>
<thead>
<tr>
<th>Damage Intensity</th>
<th>Posting</th>
<th>Usability Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light damage (Low risk)</td>
<td>Inspected (Green)</td>
<td>G1 Occupiable, no immediate further investigation required.</td>
</tr>
<tr>
<td>Moderate damage (Medium risk)</td>
<td>Restricted Use (Yellow)</td>
<td>G2 Occupiable, repairs required</td>
</tr>
<tr>
<td>Heavy damage (High risk)</td>
<td>Unsafe (Red)</td>
<td>Y1 Short-term entry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Y2 No entry to parts until repaired or demolished</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1 Significant damage: repairs, strengthening possible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R2 Severe damage: demolition likely</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R3 At risk from adjacent premises or from ground failure</td>
</tr>
</tbody>
</table>
Safety Evaluation
Issues in Christchurch

- New Zealand guidelines were under development.
- No training manual and less guidance than ATC-20 family.
- Heroic volunteer efforts, but evaluators had limited training and no credentialing program.
- Old placards were not always removed and ink faded.
- RESTRICTED USE placard not fully utilized; as “No Entry Except on Essential Business” subtitle confused issue.

Upper Photo Credit: Professor Ken Elwood, University of British Columbia
Safety Evaluation Issues

- Placard meanings were not well understood by the public.
- Confused “Safe” in the future with “Inspected”
- “Inspected” only means the original seismic resistance is not significantly decreased.
- Building safety is the primary responsibility of the building owner.
- Laws are confusing and hampered the placarding process.
- Lack of guidelines for NZ Detailed Evaluations
- Lack of repair and strengthening guidelines
Future Needs

• Research
  • Out-of-plane strengthening of cavity wall masonry
  • Understanding fractured bars in shear wall buildings
  • Performance of building shoring and stabilization methods

• Begin Process of Updating ATC-20
  • Working group to plan workshop
  • Workshop to determine update
    • Single document or
    • Family of documents
  • International collaboration desired
High Priority Steps for ATC

- ATC 20 technical guidelines and field manual update
- Guidelines for managing the postearthquake safety evaluation process: *How do you run a good program?*
- Aftershock risk guidelines
- Guidelines for private engineer posting of buildings
- Guidelines for sheltering residential occupants in place
- Cordonning, barricading, shoring and stabilization guidelines
- Seismic design and evaluation criteria for stairs
- Training of structural and geotechnical engineers in ATC 20 Detailed Evaluations

- Engineering Evaluation guidelines
- Guidelines for repair and strengthening of damaged buildings, including damage from liquefaction.
- Seismic strengthening criteria and methodology for URM cavity walls
Issues to Resolve

• Who is the audience for the tag and what are the purposes for the tag?

• Should we retain multiple levels of evaluation? To balance rapidity with thoroughness, should there still be three levels of evaluation (such as Rapid, Detailed, and Engineering)?

• Should there be different procedures and/or placards for commercial and residential buildings? The same approach is used for both building types in US, but was not in NZ.

• At what level of shaking should reevaluation and retagging be done? When there are many large aftershocks, at what point should re-inspection be triggered?
The intensity and ground accelerations in Christchurch were much larger in the February 2011 event:

- Should allowances be made for larger aftershocks?
- Should the possibility of a different direction of maximum shaking be considered?

Darfield Earthquake
4 September 2010

Slide adjusted from that of Christchurch City Council
Issues to Resolve

• The “bad” building problem
  • Is it appropriate to provide an INSPECTED tag to a building with a known form of hazardous construction (such as URM bearing walls or nonductile concrete)?
  • The INSPECTED placard merely means that the building is as safe and as viable as it was before the earthquake; it is not a guarantee of future performance.

Photo Credits: Hyland and Smith (2011)
Issues to Resolve

Should the concept of “disproportionate damage” be used?

• This is described in the ATC 52-4 document prepared for San Francisco.

• Repair requirements are more stringent for those buildings that suffered higher levels of damage in moderate to low levels of shaking.

• Triggering loss for disproportionate damage is approximately half of full damage trigger at ground motion of $S_{a_{0.3}} \leq 0.4g$. 
Issues to Resolve

Should postearthquake safety assessments be based on estimates of residual capacity?

- ATC-20 Rapid and Detailed Evaluations are based on observed damage, not a quantification of remaining capacity.

- Use of residual capacity in US Engineering Evaluation (or NZ Detailed Evaluation) is desirable.

- Guidelines for residual capacity assessments exist. Others are under development. More work is needed.
Issues to Resolve

How far should the search for hidden damage go?

• After the 1994 Northridge earthquake, guidelines were developed to recommend at what level of shaking beam-column connections in steel moment frame buildings should be investigated and what percentage of connections should be examined.

• The possibility of fractured rebar inside concrete walls poses a similar issue of how to determine when to dig into the wall.

Image Credit: SESOC Practice Note, 21 Dec 2011
Issues to Resolve

Are time limits on evaluation placards appropriate?

• The primary focus of tagging is to quickly determine whether reoccupancy is not recommended.

• As time passes, aftershock potential diminishes and recovery becomes the primary focus.

• Should tags expire?

• What does an owner need to do to get rid of a tag?
Questions?