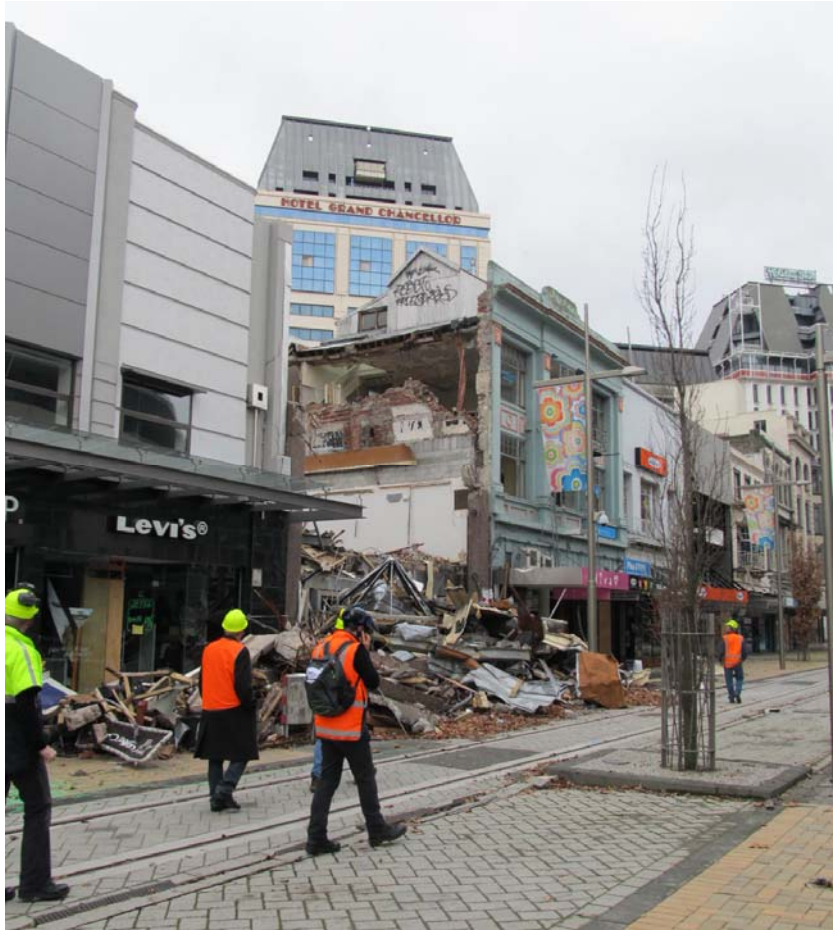
Lessons from the Postearthquake Safety Evaluation in the 2010-2011 Canterbury, New Zealand Earthquakes and Implications for Updating ATC-20



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

Bret Lizundia
Rutherford + Chekene
San Francisco

Ron Gallagher
R.P. Gallagher Associates
Oakland

December 2012

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

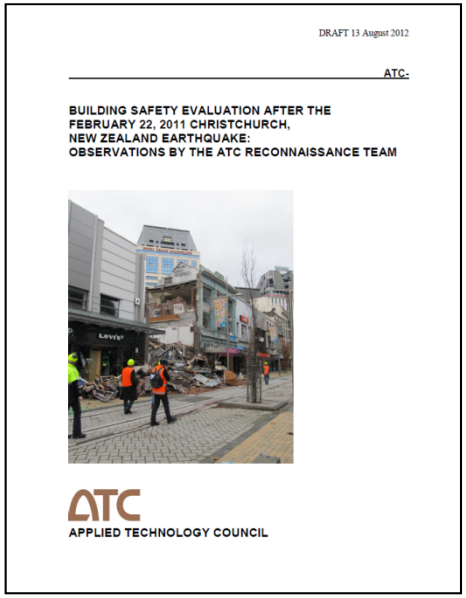
ATC Reconnaissance Trip

- 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


DRAFT 13 August 2012

ATC-

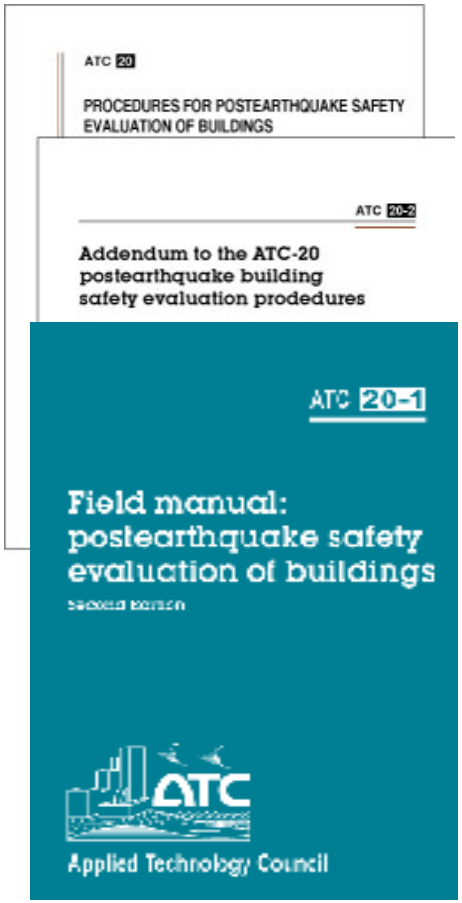
BUILDING SAFETY EVALUATION AFTER THE FEBRUARY 22, 2011 CHRISTCHURCH, NEW ZEALAND EARTHQUAKE: OBSERVATIONS BY THE ATC RECONNAISSANCE TEAM

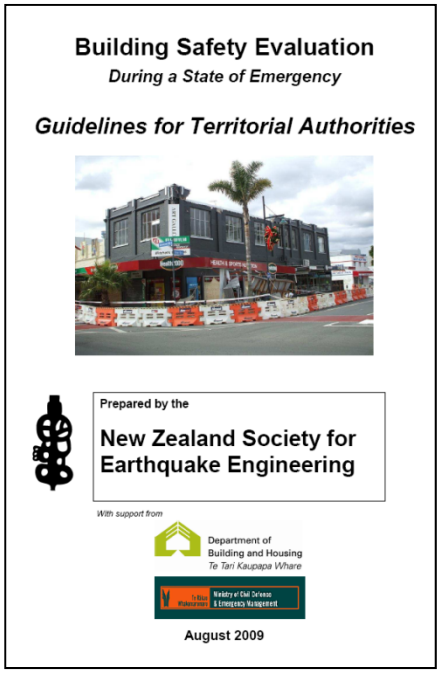
ATC

APPLIED TECHNOLOGY COUNCIL

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)

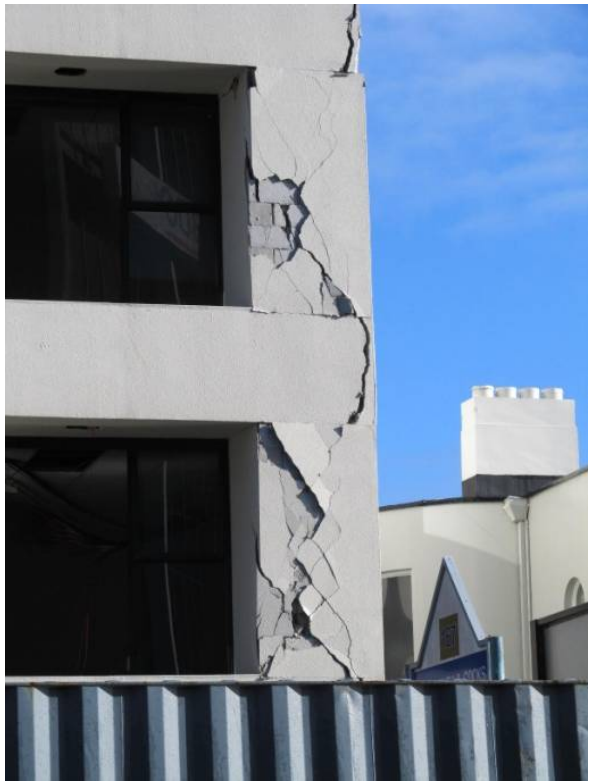




- Both use red, yellow, and green tags
- Both have three levels of evaluation
  - US: Rapid, Detailed, and Engineering
  - NZ: Rapid Level 1, Rapid Level 2, and Detailed

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, cordoning, and demolition

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

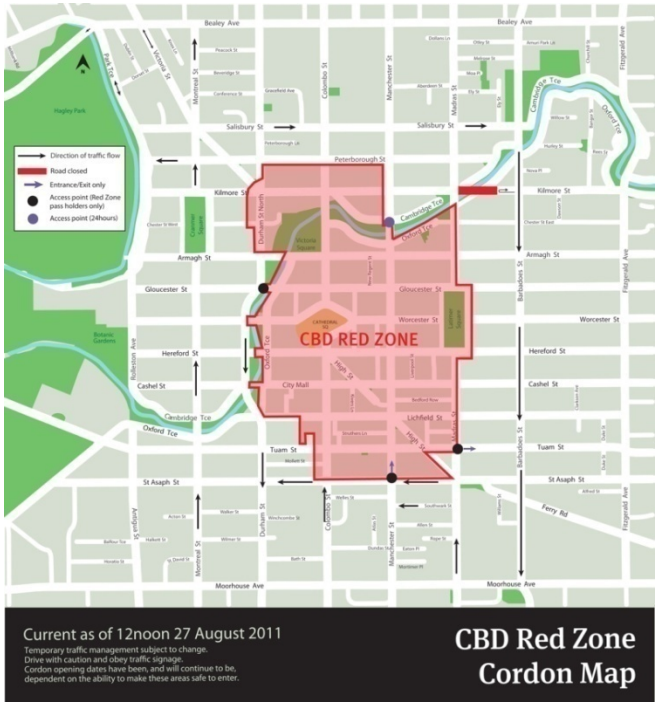
Image Credit: Christchurch City Council

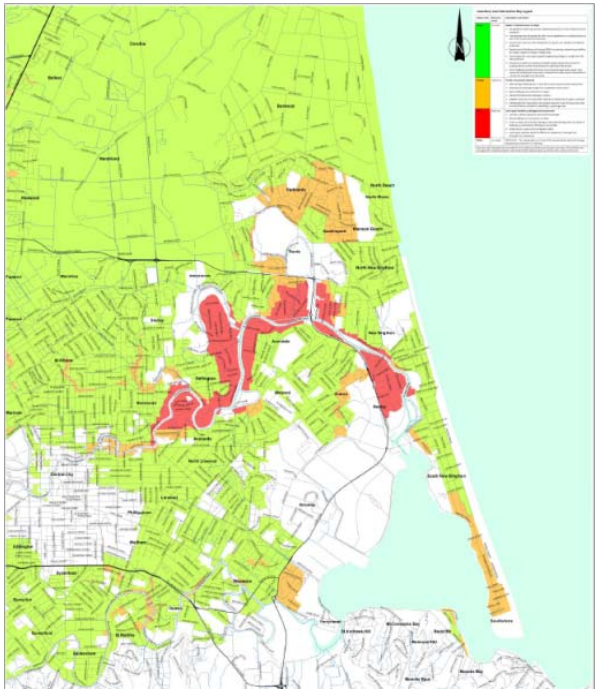
Useful Ideas/Good Practices

- CBD cordoning 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

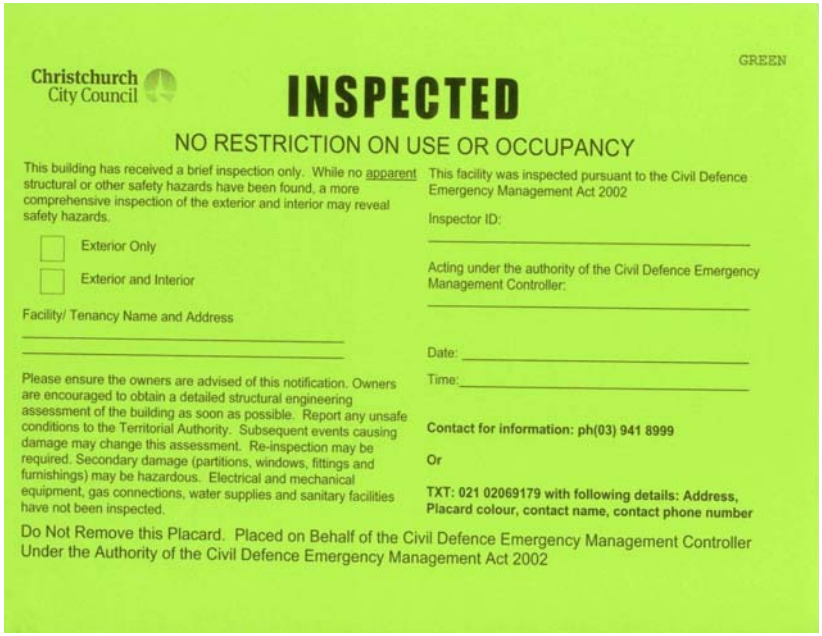
Damage Intensity	Posting	Usability Category
Light damage (Low risk)	Inspected (Green)	G1 Occupiable, no immediate further investigation required.
		G2 Occupiable, repairs required
Moderate damage (Medium risk)	Restricted Use (Yellow)	Y1 Short-term entry
		Y2 No entry to parts until repaired or demolished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

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



GREEN

Christchurch City Council

INSPECTED

NO RESTRICTION ON USE OR OCCUPANCY

This building has received a brief inspection only. While no apparent structural or other safety hazards have been found, a more comprehensive inspection of the exterior and interior may reveal safety hazards.

☐ Exterior Only

☐ Exterior and Interior

Facility/ Tenancy Name and Address

_____

_____

Please ensure the owners are advised of this notification. Owners are encouraged to obtain a detailed structural engineering assessment of the building as soon as possible. Report any unsafe conditions to the Territorial Authority. Subsequent events causing damage may change this assessment. Re-inspection may be required. Secondary damage (partitions, windows, fittings and furnishings) may be hazardous. Electrical and mechanical equipment, gas connections, water supplies and sanitary facilities have not been inspected.

This facility was inspected pursuant to the Civil Defence Emergency Management Act 2002

Inspector ID:

_____

Acting under the authority of the Civil Defence Emergency Management Controller:

_____

Date: _____

Time: _____

Contact for information: ph(03) 941 8999

Or

TXT: 021 02069179 with following details: Address, Placard colour, contact name, contact phone number

Do Not Remove this Placard. Placed on Behalf of the Civil Defence Emergency Management Controller Under the Authority of the Civil Defence Emergency Management Act 2002

- 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
- Cordoning, 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?

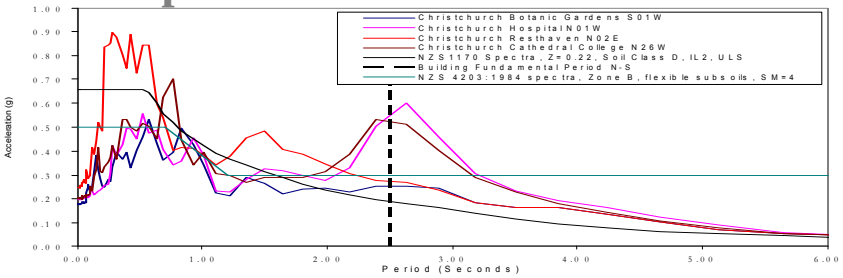
Issues to Resolve

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?*

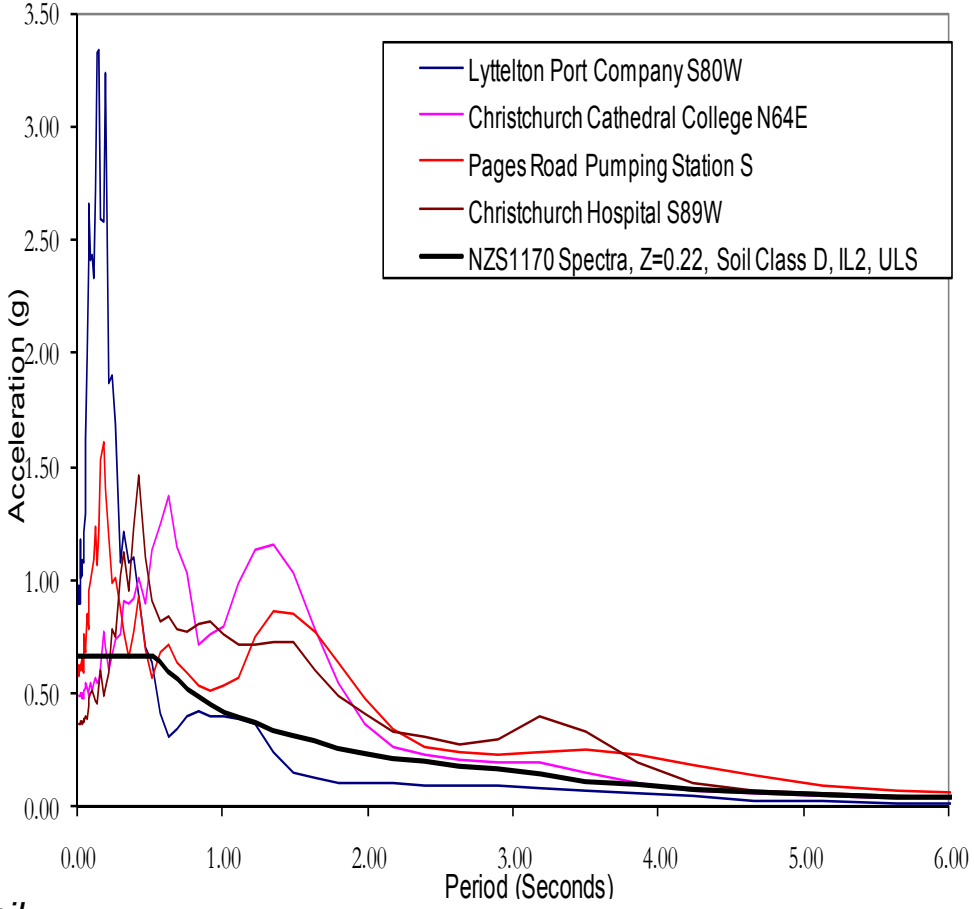
Darfield Earthquake

4 September 2010



Lyttelton Earthquake

22 February 2011



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.*

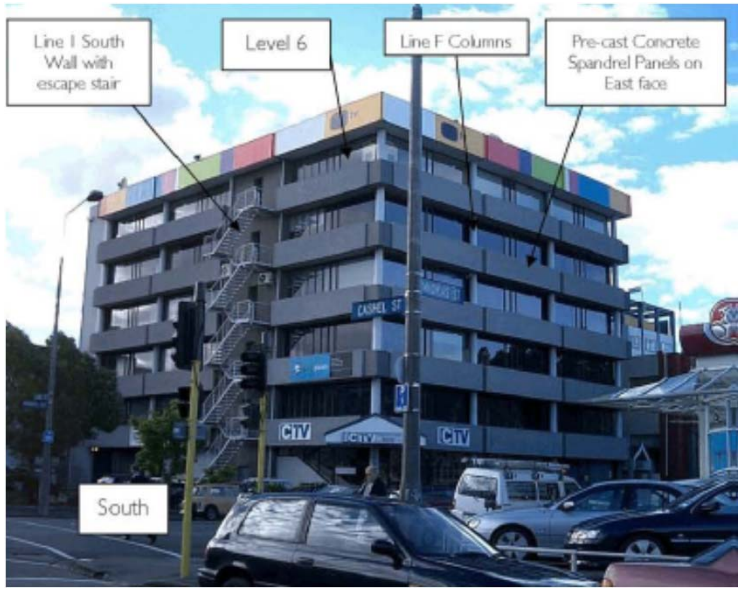
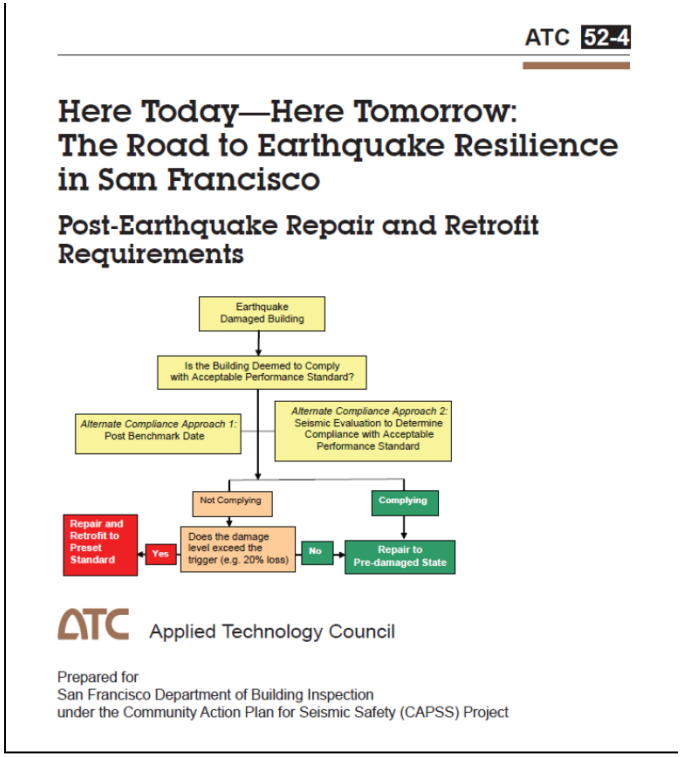


Photo Credits: Hyland and Smith (2011)

Issues to Resolve

Should the concept of "disproportionate damage" be used?

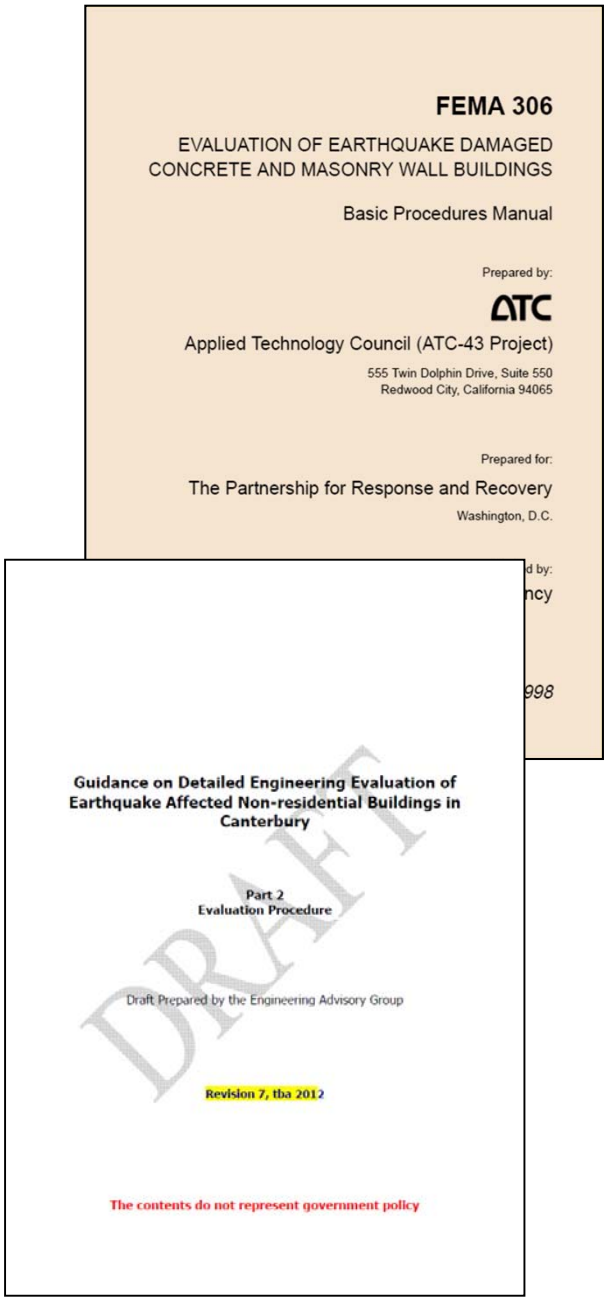
- This is described in the ATC 52-4 document prepared for San Francisco.
- Repair requirements are more stringent for those buildings that suffered higher levels of damage in moderate to low levels of shaking.
- Triggering loss for disproportionate damage is approximately half of full damage trigger at ground motion of $Sa_{0.3} \leq 0.4g$.



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?

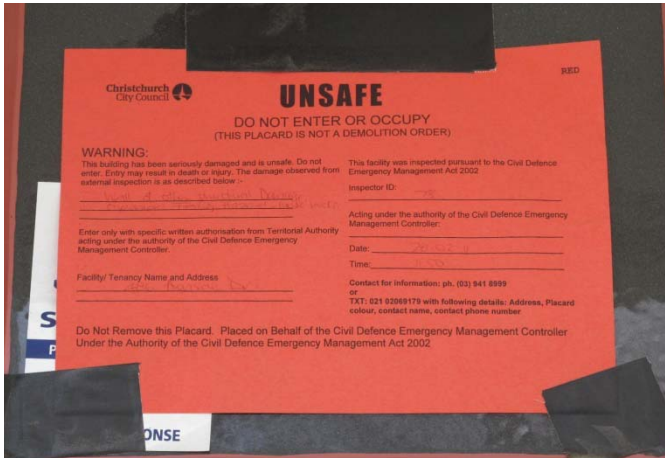
- After the 1994 Northridge earthquake, guidelines were developed to recommend at what level of shaking beam-column connections in steel moment frame buildings should be investigated and what percentage of connections should be examined.

- 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?