Wellington City Council
Targeted Assessment Programme

Briefing on Targeted Damage Evaluation Additional Guidance:

Precast Concrete Floor Systems and Cladding Panels

17 January 2017

Session Overview

- Recap on the WCC Targeted Assessment Programme
- Update on Targeted Damage Evaluation Guidance and reporting
- Briefing on Additional Guidance on Precast Concrete Floor Systems and Cladding Panels
- Your Questions and Feedback
- NZFS comments on earthquake damage to fire separations

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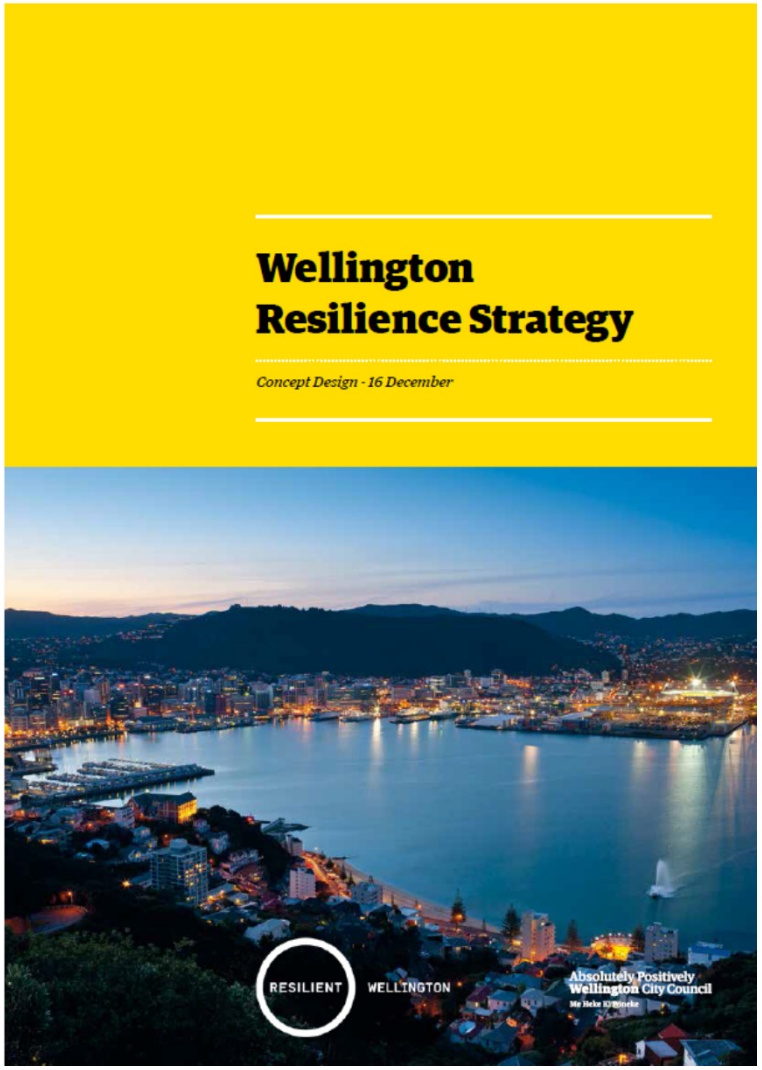
Context



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Context

1. Concerns that some owners of at-risk buildings may not have obtained adequate building structure reviews
2. The need to ensure that engineers are completing appropriate investigations
3. The need to focus on the most at-risk buildings in the aftermath of this earthquake to make the most efficient use of engineering resources
4. We are in a period of increased probability of a local earthquake
5. An initial finding by the MBIE Stats House investigation team identified a specific at risk building profile

Purpose

- To address public safety issues and to provide confidence that appropriate engineering investigations of buildings most affected by this earthquake have been carried out
- And that where necessary, appropriate repairs and remediation are being implemented
- Utilising emergency powers under the Civil Defence Emergency Management Act passed under urgency following the Kaikoura earthquakes

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Summary of Process

- Buildings within an Affected Building Profile have been identified, and owners notified
- Owners will be requested to engage engineers to undertake a Targeted Damage Evaluation
- Reports and Standardised Summary Table must be submitted to WCC by 10 February
- Engineering Guidelines outline the assessment process to be followed, including the Standardised Summary Table as a separate spreadsheet

Additional Information

- The Targeted Damage Evaluation reports will be reviewed by engineers to be engaged by WCC
- If you see any issues of direct public safety concern whilst undertaking these assessments (external or internal to the building), please contact WCC immediately
- If you have any questions regarding the process, please email buildingsassessments@wcc.govt.nz

Update on Targeted Damage Evaluation Guidance

- Engineering Guidelines for Targeted Damage Evaluation V1.0 issued 19 December - *unchanged*
- Standardised Summary Table (Excel spreadsheet) – *V1.23 available SESOC website tomorrow*
- Additional Guidance Notes for Targeted Damage Evaluation: Precast Concrete Floor Systems and Cladding Panels – *handout version/ available SESOC website tomorrow*

Recap: Reporting Format and Structure

1. Description of Structure
2. Inspections and Assessments Undertaken
3. Information Sources
4. Damage Observed
5. Occupancy Recommendations
6. Further Actions Proposed

Appendix A – Rapid Assessment Forms

Appendix B – Standardised Summary Table

Key Changes to Standardised Summary Table Spreadsheet

- Number of fields reduced
  - a number of voluntary/ optional fields removed
- Mandatory fields highlighted in red
- Adjustment to Critical Damage State recording to reflect Additional Guidance Note
- Drop down list to categorise occupancy recommendations

Scope of Additional Technical Guidance

- To be read and used in conjunction with the Targeted Damage Evaluation Guidelines V1.0
- Planning and undertaking investigations of precast floor systems and cladding elements
- Clarifying the scope of investigations – 'Progressive Inquiry'
- Highlighting that Critical Damage States refer to component damage
  - Some relate to local capacity issues, others relate to overall stability
- Occupancy considerations

Recap: Critical Damage States

A - Damage posing collapse risk (possibly without aftershock)

B - Damage posing local and global collapse risk (in case of aftershock)

C - Damage to primary structure posing lower risk

D - Damage to secondary structural and non-structural elements that may cause increased life safety risk

'Progressive Inquiry'

- Review available drawings for building configuration issues that indicate likely damage 'hotspots'
- Undertake an *Initial Investigation* to inspect identified hotspots
- Undertake *Intrusive Investigations* to the extent necessary
- If evidence of damage to precast flooring or panel connections is observed in hotspots or other areas, extend the investigation to other regions on levels with highest drift demands
- If evidence of damage to precast flooring or panel connections is not identified in hotspot or other inspected locations, no further intrusive investigation is required

'Progressive Inquiry' (cont'd)

This approach provides a reasonable likelihood of finding any Critical Damage States A or B, or D

- BUT it must be noted that it is not practically possible to guarantee that none are present

Precast Concrete Floors:
Building Configuration Issues

- Moment-resisting frames where precast floor units span in parallel across multiple frame bays
- Irregular floor layout (including L-shaped or curved floor plans and irregular layout of lateral force resisting systems)
- Large openings or re-entrant corners in diaphragms impacting load path to lateral force resisting systems
- Transfer beams
- Nominal or lack of structural ties across the floor plate holding the columns of a frame or braced bay into the building.

Precast Concrete Floors:
Example "Hotspots"

- Corners of the building
- Locations of torsional demand or concentrated deformations on precast units (e.g. between two adjacent walls or adjacent to eccentrically braced steel frames)
- Corners of large diaphragm openings
- Precast units with continuity restraint at gravity beams near gravity columns

Precast Concrete Floors:
Initial Investigation

- Representative inspections of hotspots:
  - e.g. two opposing corners on three levels;
  - two of these to be on levels of highest drift demand
  - Note that precast unit damage can occur with limited to no beam elongation evidence
- Expose top and bottom of floor surfaces and floor unit supports in hotspots
- If CDS A or B identified (next slides) expand investigation
  - Randomly distribute inspection locations on floors of likely highest drift demand to reduce chance of missing damage.

Precast Concrete Floors:
Initial Investigation

- Looking for damage patterns indicating floor units have sustained at least Critical Damage State B:
  - transverse cracks across hollow core units (within 400 mm of supporting beam);
  - diagonal cracks at end of ribs (within 400 mm of supporting beam);
  - damage to support for precast floor units;
    - eg. excessive spalling of hollowcore seatings or crushing of concrete in double tee exposing pigtail
  - reduced seating

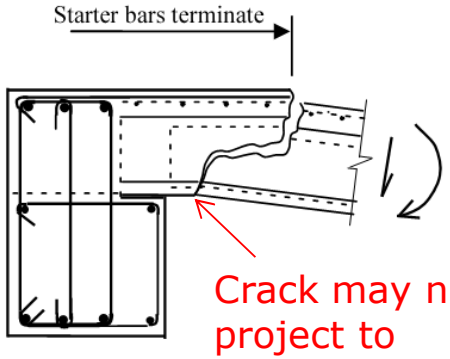
Precast Concrete Floors:
Initial Investigation

If the following damage features are present:

- Vertical offset at crack
- Diagonal cracking in hollowcore web (in direction of gravity shear)
  - Intrusive inspection required to sight condition of webs
  - If not inspected, must assume diagonal crack exists

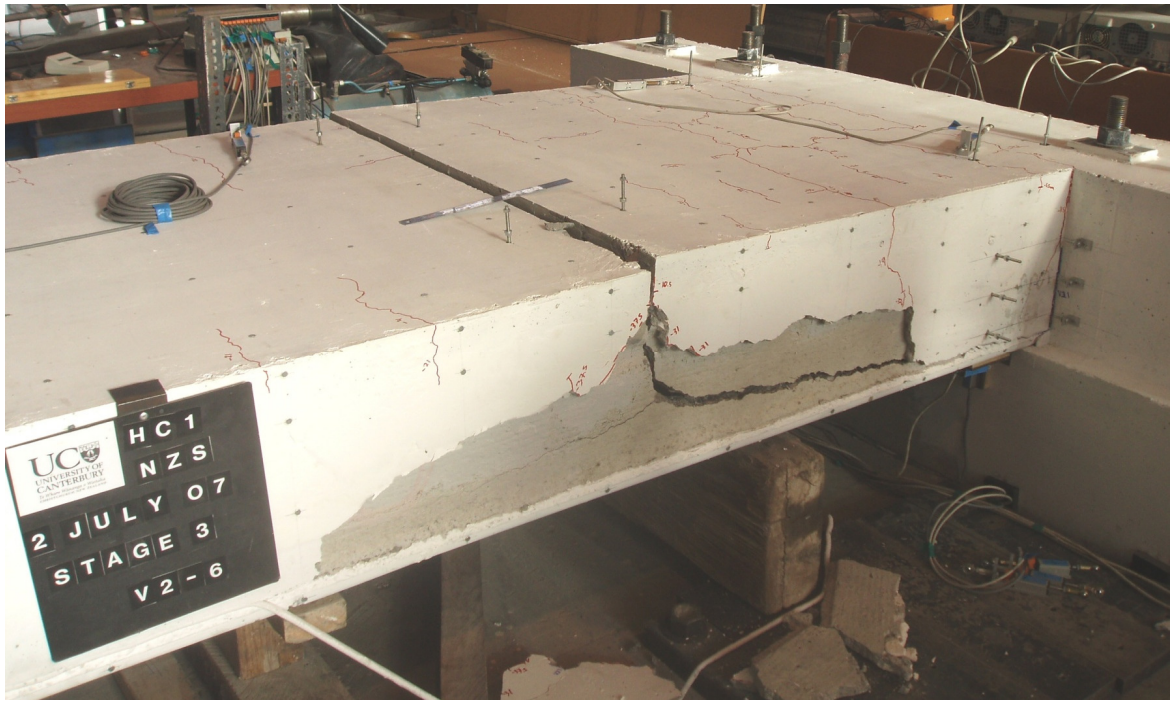
➢ Re-classify as Critical Damage State A

Transverse crack at end of hollow core

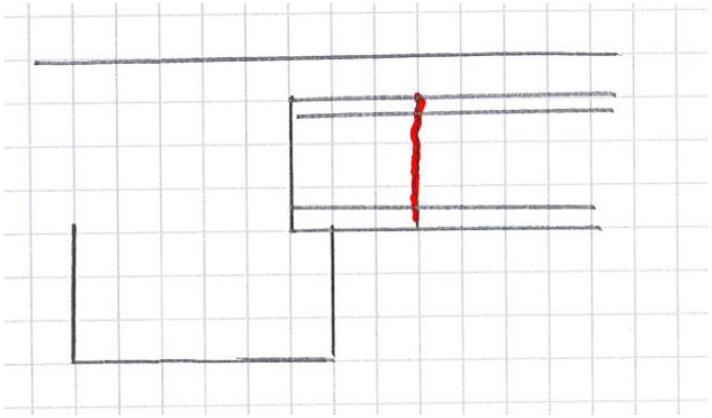


Lift the carpet at end of starter bars.
Start in the corners.
Use level to check for vertical offset.

With vertical offset OR diagonal crack in web
→ CDS A

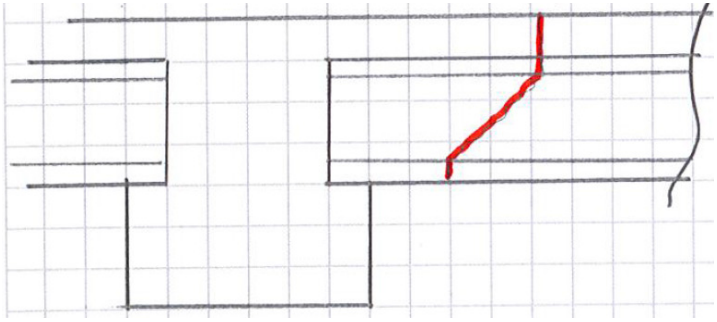


Transverse crack at end of hollow core



→ CDS B

But if



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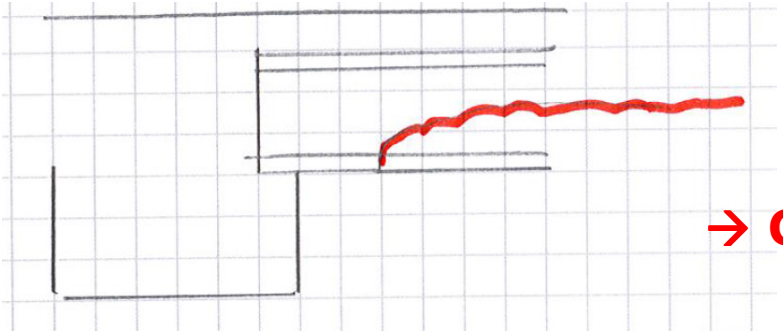


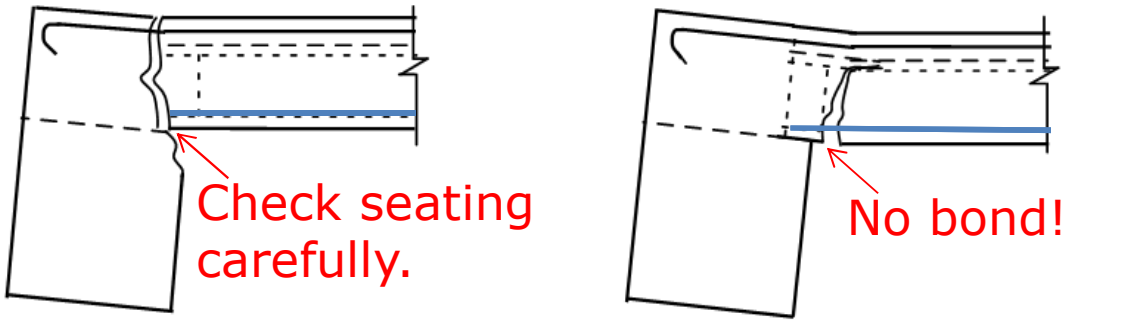
→ CDS A

Transverse crack at end of hollow core

Example damage from the field:

→ **At least CDS B**

Transverse crack at end of hollow core



(a) Loss of support with critical section at back face of precast unit

(b) Positive moment flexural failure with critical section near front face of support (see Section A4)

Figure A-4: Loss of support and positive moment flexural failure

With vertical offset → CDS A

Figure 5-9: Positive moment failure of hollow-core unit (Photo from reference 7)

Transverse crack at end of hollow core

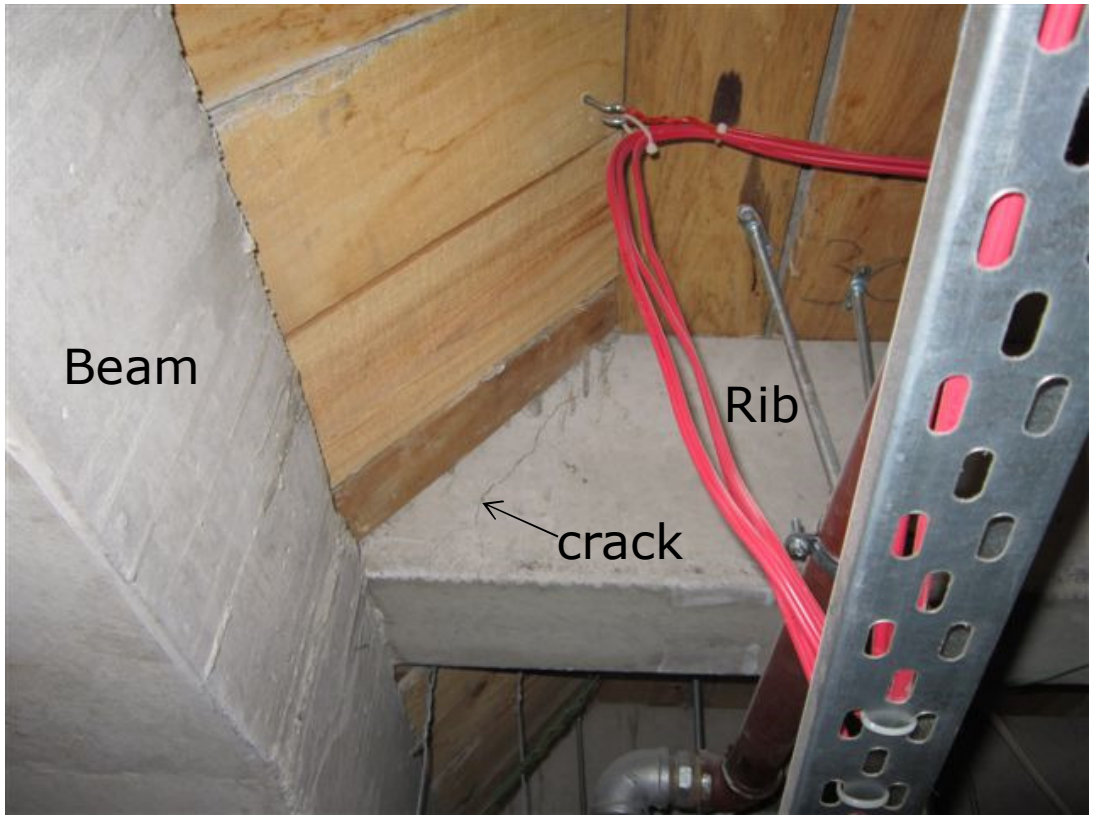
Example damage from the field (corner of hollow core):

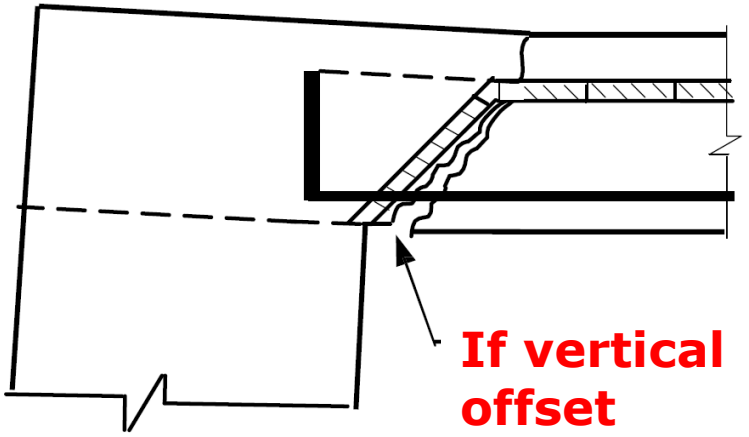
→ At least CDS B

Need to inspect webs of hollow core for diagonal cracks.

Transverse crack at end of ribs

Example damage from the field (Ribs):





If vertical offset → CDS A

- **If crack width at level of lowest strand < 0.4 mm → <u>not</u> CDS B (or A)**

Damage to support for flange hung double tee

Example damage from the field:

→ **CDS A**

Longitudinal cracking of hollow core

Example damage from the field:

Not a collapse concern, but impacts diaphragm performance
→ CDS C

Precast Panels

- **Focus** - identifying panel connections that have been compromised such that there is no valid load path restraining the panel from falling in an aftershock or other earthquake event (Critical Damage State D2)
- The general philosophy and methodology is also considered valid for stairs and other heavy overhead non-structural elements (Critical Damage States D1 and D3)
- The process to be followed is essentially the same as for precast concrete floor systems ('Progressive Inquiry')

Precast Concrete Panels:

Plan Review

Key indicator issues include:

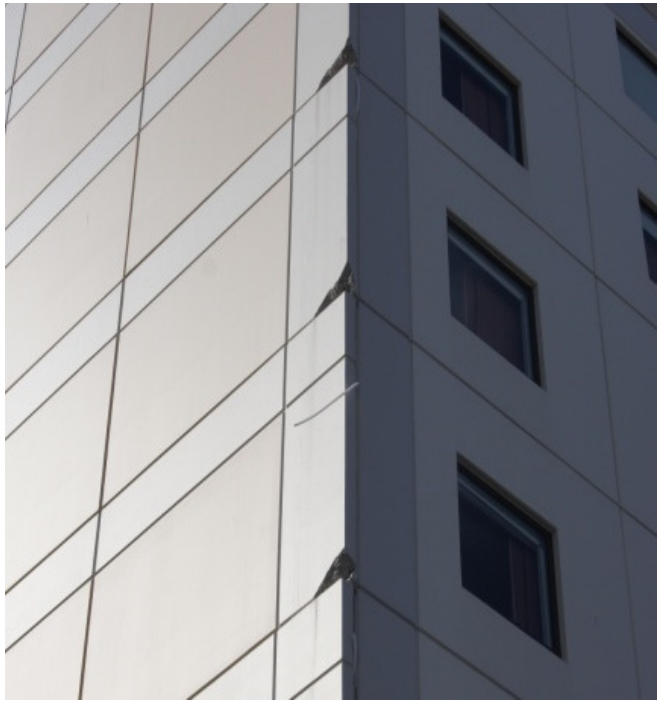
- Fixings embedded into plastic hinge regions of beams
- Rigid connections to beams that may have elongated
- Fixings with limited or no clearance to accommodate inter-storey drift
- Fixings in panels that have no mechanical interlock with the panel reinforcement or that are reliant on shallow embedded or drilled-in anchors
- Panels that are in line with structural elements and that do not have sufficient clearance to accommodate inter-storey drift
- Fixings that have welds at the point of highest stress concentration, particularly in case of site and fillet welds

Precast Concrete Panels:

External Viewing of Facade

Focus – identifying possible panel damage or movement

- Cracked glass panels
- Loose shims or PE backing rods
- Torn sealant
- Spalled concrete
- Cracking in panels that may relate to primary fixings



Precast Concrete Panels:

Identifying Hotspots for Intrusive Investigation

- From plan review and external viewing
- In conjunction with precast floor system hotspot inspections
- Focus on identifying areas where damage relating to deformation incompatibility has occurred in other components
- And/ or where the internal non-structural damage is indicating that the building has undergone significant deformations

Precast Concrete Panels:
Intrusive Investigation

Specific issues to look for when investigating panel connections include:

- Sheared, deformed or missing bolts
- Deformed brackets or connections
- Cracked concrete around brackets
- Panel movement as a result of the earthquake that has used up all of the deformation capability

Deformed connections

Cracked and spalled concrete

All the movement tolerances taken up

‘Progressive Inquiry’

- Review available drawings for building configuration issues that indicate likely damage ‘hotspots’
- Undertake an *Initial Investigation* to inspect identified hotspots
- Undertake *Intrusive Investigations* to the extent necessary
- If evidence of damage to panel connections is observed in hotspots or other areas, extend the investigation to other regions on levels with highest drift demands
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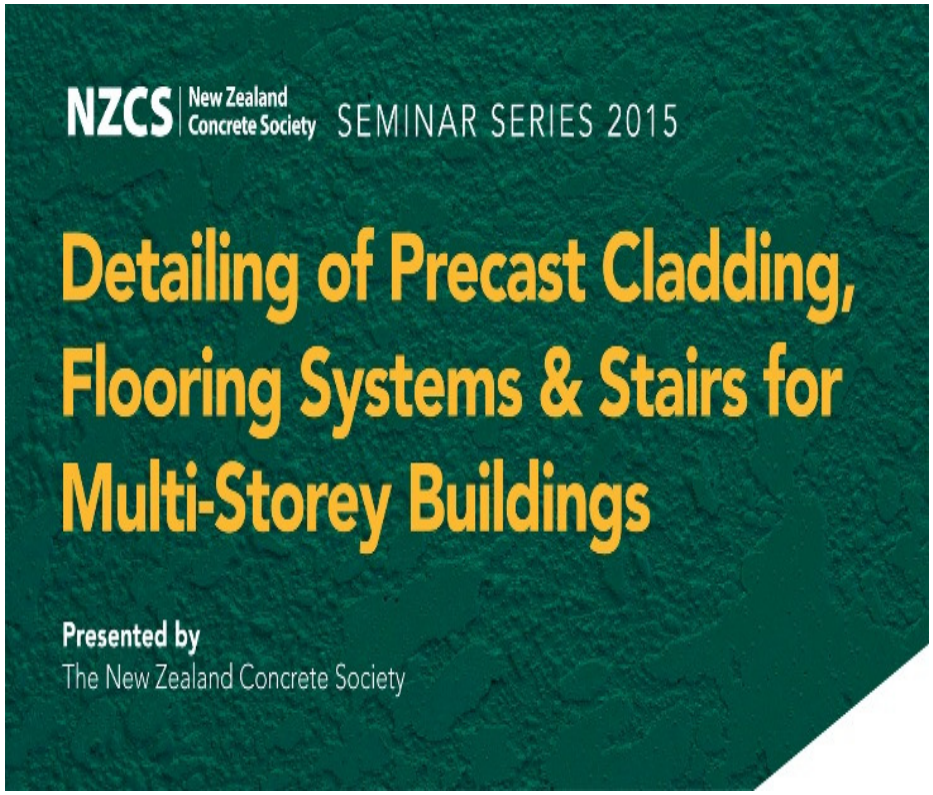
For Best Practice Information



http://www.concretesociety.org.nz

Occupancy Considerations

- Reminder that Critical Damage States refer to component damage
- Compromised local capacity – *local propping and/ or isolation can be sufficient*
- Overall stability of the building – *not appropriate for building to be occupied*

Occupancy Recommendations

- Suggested that recommendations on occupancy use following categories/ descriptors:
  - Continued normal occupancy with no restriction
  - Continued occupancy with partial access restriction
  - Not to be occupied pending further investigation and/ or repairs.
- A statement should also be made as to the need for external barricading of public or otherwise accessible spaces.

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Additional Guidance Notes for Targeted Damage Evaluation:

Precast Concrete Floor Systems and Cladding Panels

17 January 2017

Overview

This additional guidance elaborates on the information provided in the *Engineering Guidelines for Targeted Damage Evaluation following the November 2016 Kaikoura Earthquakes* Version 1.0 (the Guidelines). These notes focus on precast concrete floor systems and cladding elements, and should be read in conjunction with Section 5 of those Guidelines. The guidance given herein is in addition to the Guidelines - that is, the overall building evaluation should otherwise follow the Guidelines.

Additional information is provided about planning and undertaking investigations of precast concrete floor systems (Section 1) and precast cladding elements (Section 2), and the extent of inspections and investigations required. The information in these sections relates to establishing the presence of Critical Damage States A (local collapse risk) and B (local and global collapse risk in case of aftershock), and D (secondary structural and non-structural elements) respectively.

Further guidance is given on occupancy status with regard to the observed component damage (Section 3).

This information draws upon observations of buildings of different configurations and damage levels in the early stages of Wellington City Council's Targeted Assessment Programme.

Questions and Feedback