



LESSONS FROM SEISMIC ASSESSMENT IN WELLINGTON REGION

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**HARRISON
GRIERSON**

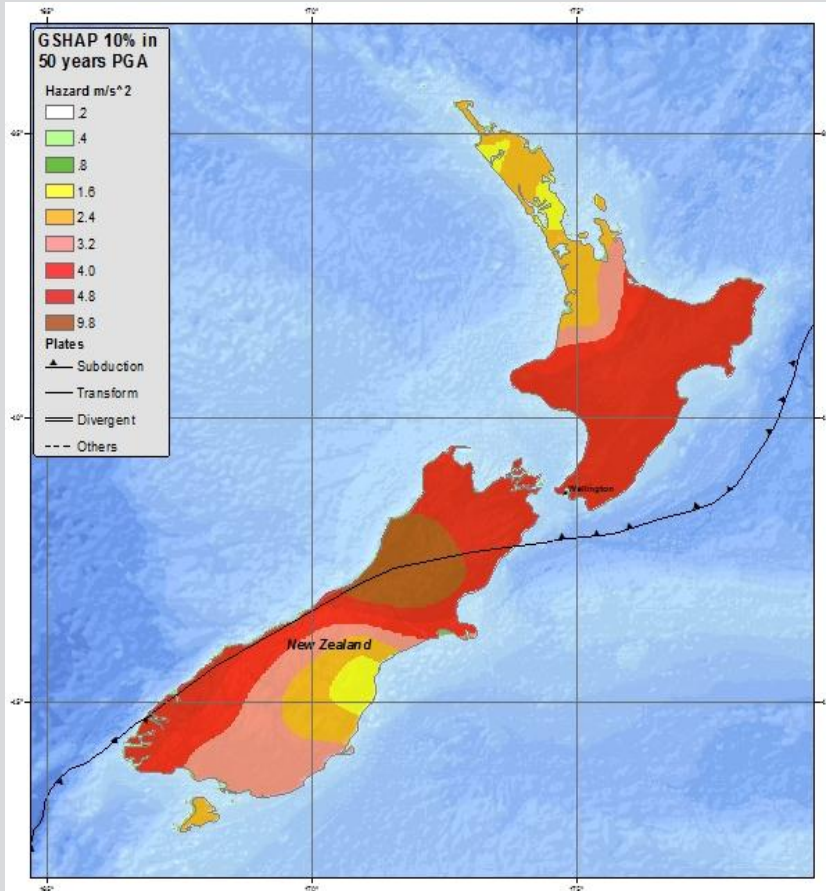
BUILDING A BETTER NEW ZEALAND
2014 CONFERENCE



- **INTRODUCTION**
 - Seismic assessments in New Zealand
 - The 2013 Earthquakes in Wellington
- **LESSONS FROM THE 2013 EARTHQUAKES**
 - Case study-1: Pounding issue
 - Case study-2: Fit-out detailing issue
- **CONCLUSIONS**

INTRODUCTION

NEW ZEALAND IS A SEISMIC COUNTRY



Seismic Hazard Map of NZ

(Source: USGS)

List of earthquakes in NZ:

- [M 6.6, Lake Grassmere, 16 August 2013](#)
 - [M 6.3, Christchurch, 22 February 2011](#)
 - [M 7.1, Darfield \(Canterbury\), 4 September 2010](#)
 - [M 7.8, Dusky Sound, 15 July 2009](#)
 - [M 6.7, Gisborne, 20 December 2007](#)
 - [M 6.5, Edgecumbe, 2 March 1987](#)
 - [M 7.1, Inangahua, 24 May 1968](#)
 - [M 7.0, Wairarapa II, 2 August 1942](#)
 - [M 7.2, Wairarapa I, 24 June 1942](#)
 - [M 7.6, Horoeke, 5 March 1934](#)
 - [M 7.8, Hawke's Bay, 3 February 1931](#)
 - [M 7.8, Buller \(Murchison\), 17 June 1929](#)
 - [M 7.1, Arthur's Pass, 9 March 1929](#)
 - [M 7.0 - 7.3, North Canterbury, 1 September 1888](#)
 - [M 7.2 - 7.6, Cape Farewell, 19 October 1868](#)
 - [M 8.2 - 8.3, Wairarapa, 23 January 1855](#)
 - [M 7.4 - 7.7, Marlborough, 16 October 1848](#)
- [More New Zealand Earthquakes](#)

(Source: geonet.org.nz)

HISTORIC NEW ZEALAND LOADING CODES

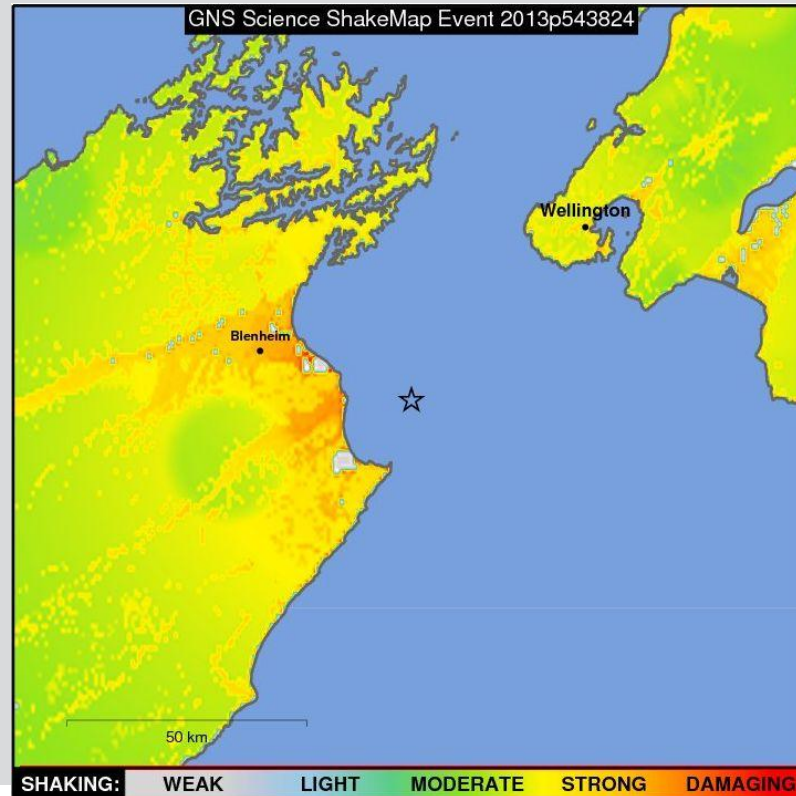


- **1931 draft code**
Draft General Earthquake Building By-law
 - **1935 code: NZSS No.95**
NZ Standard Model Building By-Law
 - **1965 code: NZSS 1900**
NZ Standard Model Building By-Law
 - **1976 and 1984 codes: NZS 4203**
Code of Practice for General Structural Design and Design Loadings for Buildings
 - **1992 code: NZS 4203**
General Structural Design and Design Loadings for Buildings
 - **2004 code: NZS 1170**
Structural Design Actions – Part 5: Earthquake Actions – New Zealand
- **Building Act 2004 – Subpart 6**
covers dangerous, earthquake prone and insanitary buildings
 - **Local Councils**
required to draft their own policy to address earthquake prone buildings
 - **NZSEE (2006)**
published a guideline for assessment of the structural performance of buildings in earthquakes

EARTHQUAKES IN WELLINGTON REGION

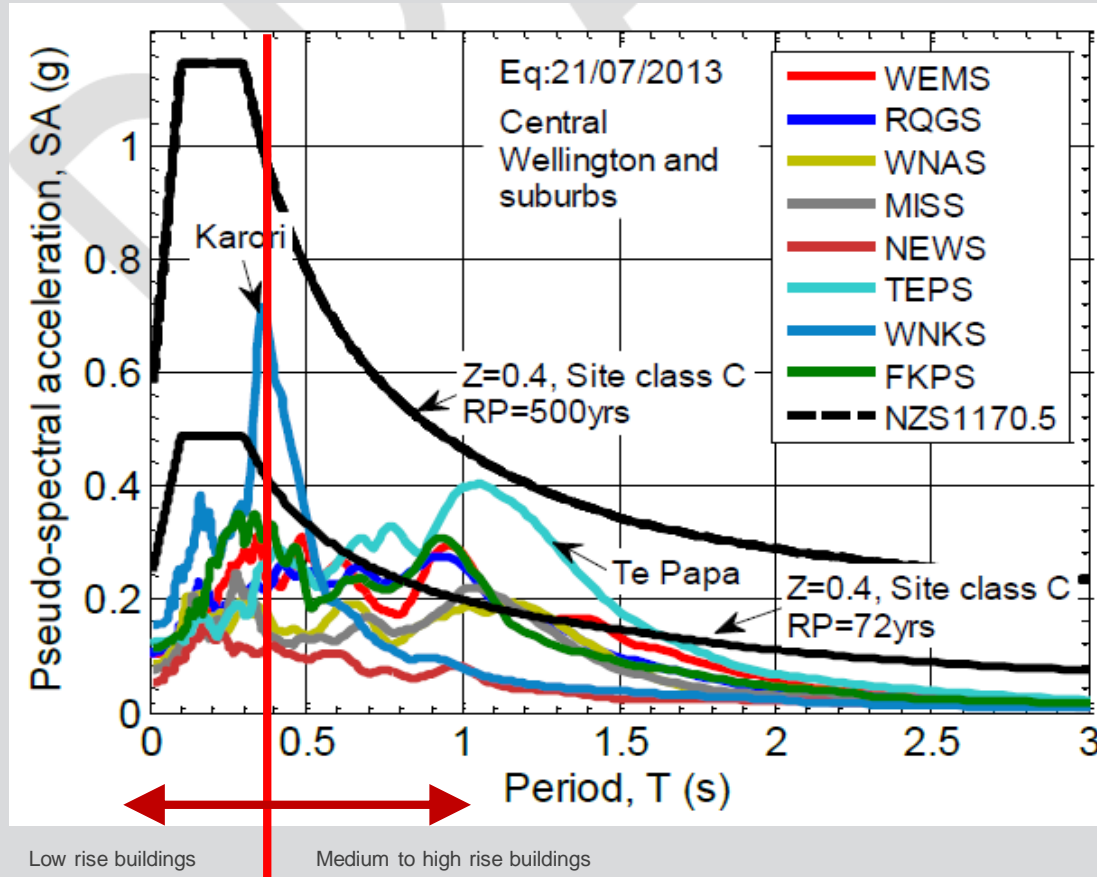


- High number of seismic assessments (IEPs and DSAs)
- Seddon earthquake – 21 July 2013
- Lake Grassmere earthquake – 16 August 2013



EARTHQUAKES IN WELLINGTON REGION

- Lessons from:
Seismic assessment vs. After-earthquake investigations

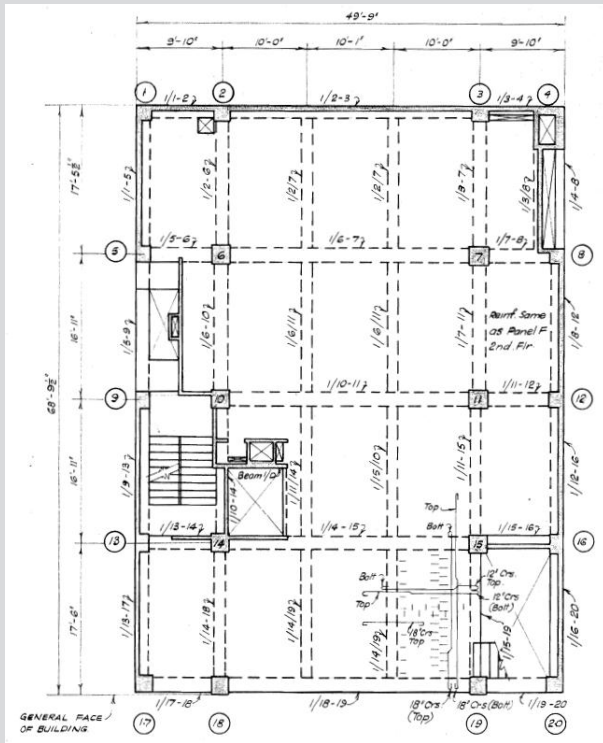




LESSONS FROM 2013 EARTHQUAKES



CASE STUDY-1:



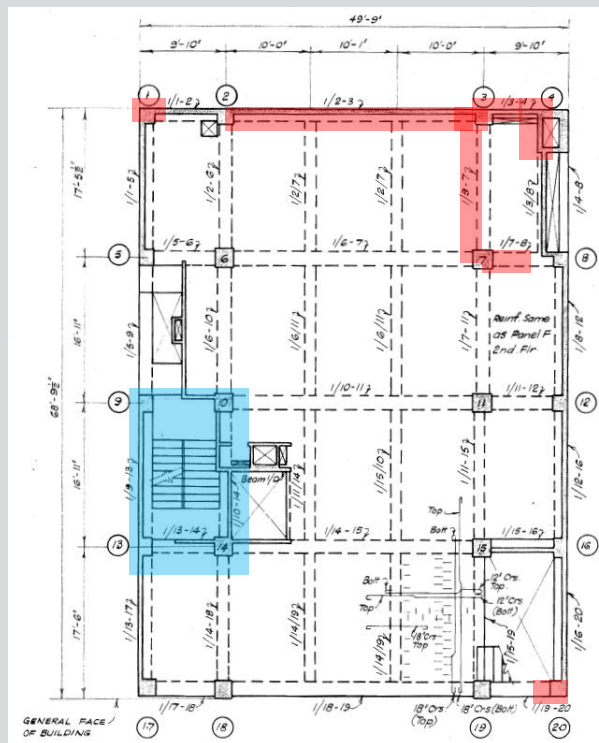
CASE STUDY-1: POUNDING ISSUE



critical components






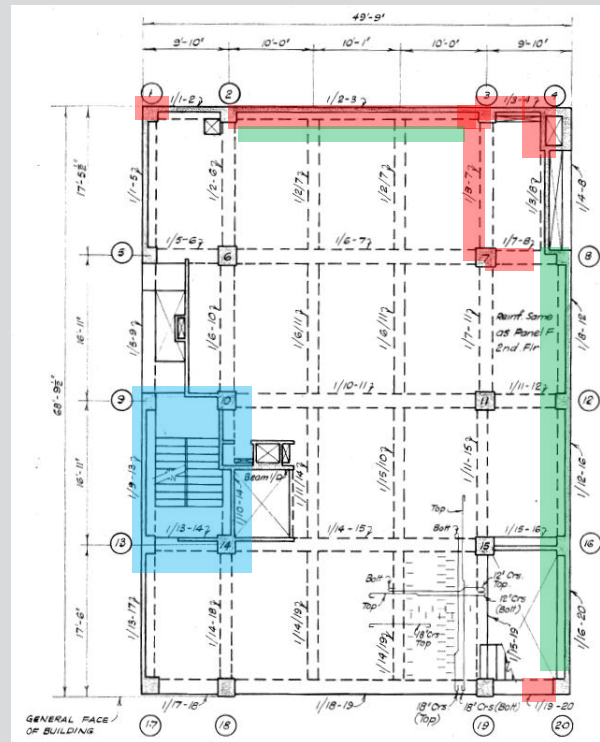
area of cracks-1



CASE STUDY-1: POUNDING ISSUE






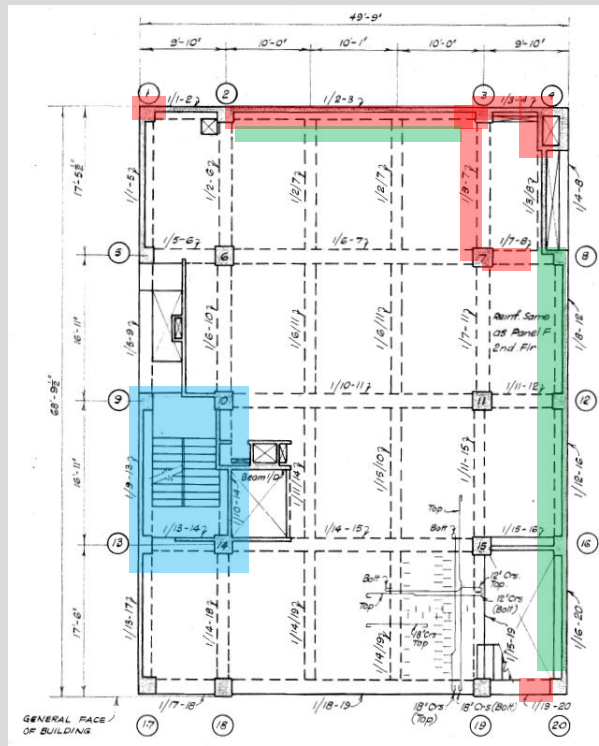
-  critical components
-  area of cracks-1
-  area of cracks-2



CASE STUDY-1: POUNDING ISSUE



-  critical components
-  area of cracks-1
-  area of cracks-2

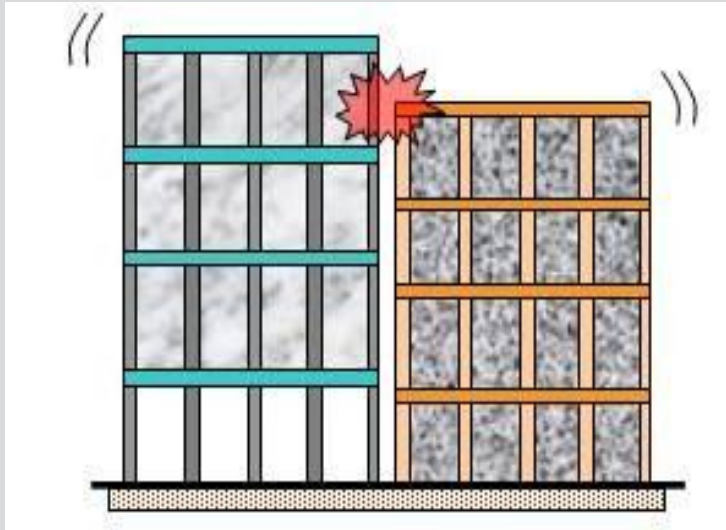


CONCLUSION: the critical components (desktop study) \neq the area of cracks (site investigation)

CASE STUDY-1: POUNDING ISSUE



Pounding: impact between buildings during earthquakes



Mid-floor failure of a hotel caused by pounding after the Mexico earthquake in 1985

DISCUSSION: POUNDING ISSUE

Multi-storey buildings in Wellington:
very limited gaps between the
neighbouring buildings

Houses in Wellington: sufficient distance
between the houses



DISCUSSION: POUNDING ISSUE



High-rises in Beijing

DISCUSSION: POUNDING ISSUE



High-rises in Dubai

DISCUSSION: POUNDING ISSUE



High-rises in Jakarta

DISCUSSION: POUNDING ISSUE



High-rises in Shanghai

DISCUSSION: POUNDING ISSUE



High-rises in Pudong

DISCUSSION: POUNDING ISSUE



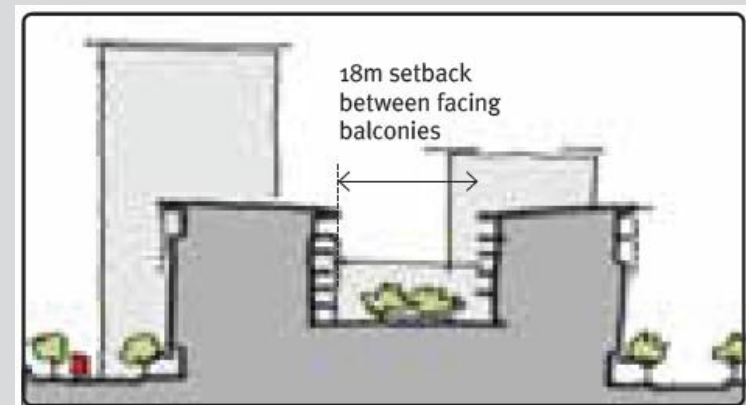
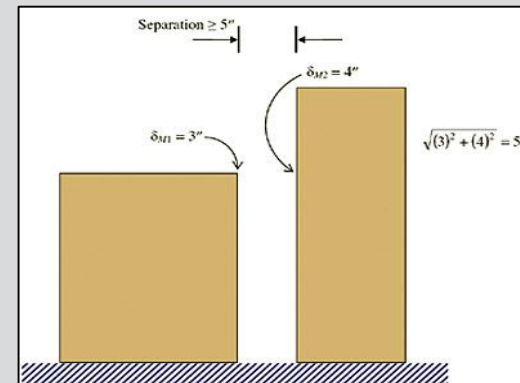
High-rises in Singapore

DISCUSSION: POUNDING ISSUE

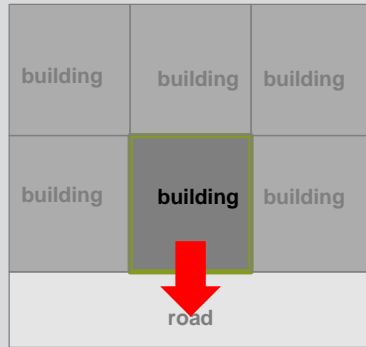


Some countries have regulations to determine the distance between two buildings

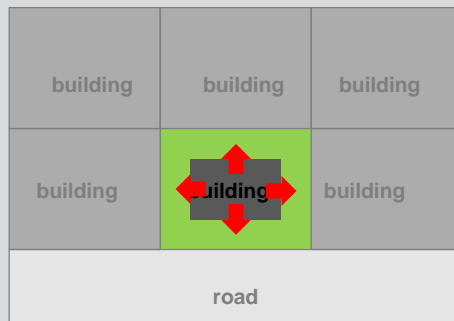
- **Jakarta, Indonesia:**
for buildings > 8-storeys → 4 m on the ground
additional floor → additional 0.05 m
- **IBC 2009 section 1613.6.7**
- **PDA guideline no. 8 - Queensland:**
setback for medium and high-rise buildings



DISCUSSION: POUNDING ISSUE



Building without offset



Building with offset

RECOMMENDATION:

Regulation to determine the distance between two multi-storey buildings that allows for:

- Building lateral displacement caused by earthquakes and wind
- Open view from each side and better natural air circulation
- More egress

CASE STUDY-2:



Shopping centre complex in Wellington region

CASE STUDY-2: FIT-OUT DETAILING ISSUE



Gib-board clad partition walls were separated from the steel frame

THE ISSUE:

Lack of integration between structural and non-structural elements

Gib-board failure along the secondary timber framed partition wall



CASE STUDY-2: FIT-OUT DETAILING ISSUE



Ceiling failure in a new-built building

THE ISSUE:

Lack of integration between structural and non-structural elements





THE ISSUE:

Lack of integration between structural and non-structural elements

RECOMMENDATION:

More extensive effort to achieve structural performance of:

- Main structure and Non-structural components
- Integration of the non-structural members and the main structure (detailing)

THE EFFORTS:

Emphasis the application of:

- NZS 4219 – Seismic performance of engineering system
- Section 8 NZS 1170.5 all parts of structures shall be designed for earthquakes loads

CONCLUSIONS



To build a better New Zealand, new building designs must consider:

- **SUFFICIENT GAP**

- Avoid an impact between two buildings (pounding)
- Provide better natural air circulation and open view
- Provide sufficient egress

- **INTEGRATED BUILDING COMPONENTS**

Provide sufficient structural performance of:

- Main structure and Non-structural components, and
- their integration (detailing)

Emphasis the application of:

- NZS 4219 – Seismic performance of engineering system
- Section 8 NZS 1170.5 all parts of structures shall be designed for earthquakes loads

HC