Insights from Intensive Assessment Analyses

An outline of Targeted Performance Enhancement
BUILDING OUTLINE

- Mid 1990s ductile RC moment-frame
- 200mm hollowcore + 70 mm topping r/w 665 mesh
- Three parts to the primary building
  - North block
  - Core
  - South block
• Detailing of the MRFs generally meets current Code ductile detailing
• Canterbury Earthquakes produced limited frame damage but significant façade panel and fixing damage
• Extensive and locally severe diaphragm slab damage
ASSESSMENT

• Post EQ damage review and correlations to analysis
  • Floor slab crack-maps to track mesh damage/fracture
  • Indicative comparison of observed movement vs expected movement
ASSESSMENT

- Hand-calculation => linear-elastic dynamic => non-linear dynamic
- NLRH assessment utilised ASCE 41-13 backbone and performance limit definitions
  - The updated NZ assessment guidelines are set to recognise ASCE 41-13 for non-linear modelling parameters
- NLRH typically focussed on finding the maximum %DBE that meets Code requirements/intent
- Incremental Dynamic Analysis - 8% steps up to 100% DBE
• IDA identified critical performance points
**Pathway to the retrofit target**

- **Hollowcore seating collapse CLS**
  - Limit existing frame ductility demand < 2.0 => frame elongation
  - Install rectangular steel section ‘catch ledges’

- **Core diaphragm strength**
  - Maintain floor seating at DBE
  - Introduce a 600mm seismic gap

- **Diaphragm strengthening**
  - Introduce new floor infills at perimeter

- **Ductility assessment for design**
  - Yield drift to review target max drift limits

- **MRF plastic rotations and drift limit 1.5%**
  - Fluid Viscous Dampers \( \alpha = 0.5 \) + BRB frames

- Increasing Owner discussion
REPAIR TOWARDS RESILIENCY

Hollowcore "alpha-unit" replacement floor infills with diaphragm drag ties shown in green

Introduced seismic gap as part of retrofit

Retrofitted steel BRB and damped frames in red

Holmes Consulting Group
1000 year EQ DBE/Ultimate Limit State
KEY POINTS

• Retrofit project that presented typical issues in existing buildings such as poor in-plan layout and flexibility
  • Aspects that static approaches will indicate, but not necessarily provide complete retrofit inputs
• Intensive non-linear IDA assessment phase provides a case-study of advantages for NZ to more readily adopt NLRH following ASCE41-13
• Retrofit target drift of 1.5% satisfied a number of different performance criteria…it was a ‘sweet-zone’
• Combination of viscous damping and BRB frames provided reduced drift/frame demands and a reasonably even distribution over the building height
QUESTIONS?