Insights from Intensive Assessment Analyses

An outline of Targeted Performance Enhancement

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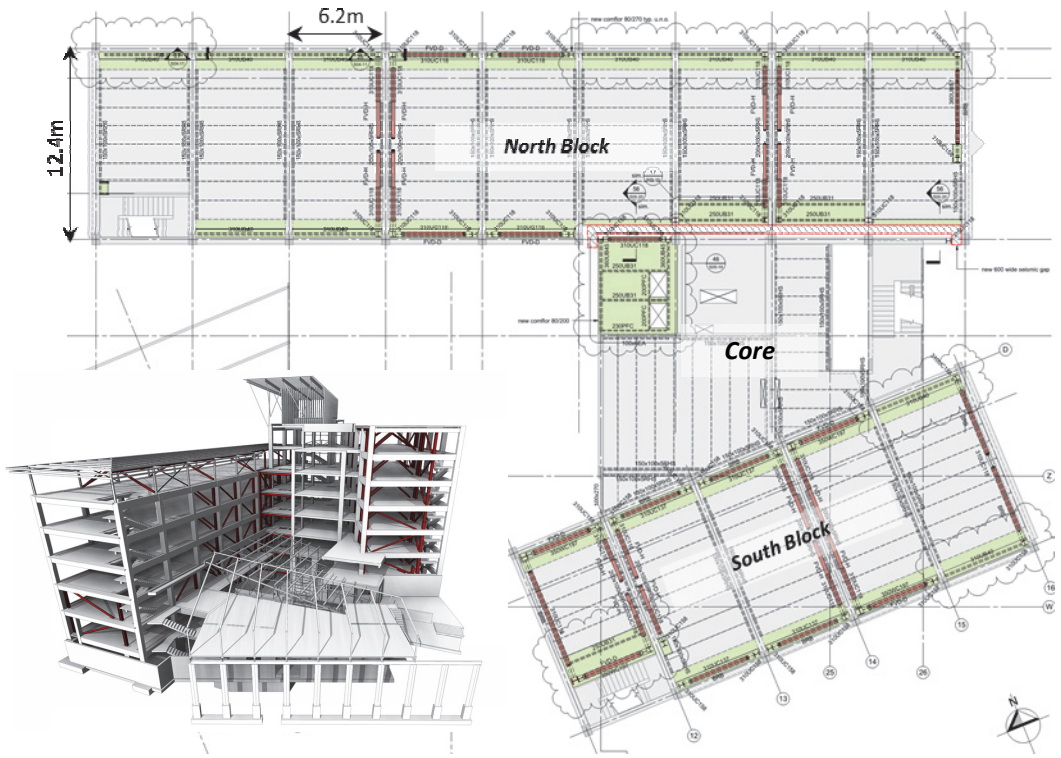
BUILDING OUTLINE

- 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

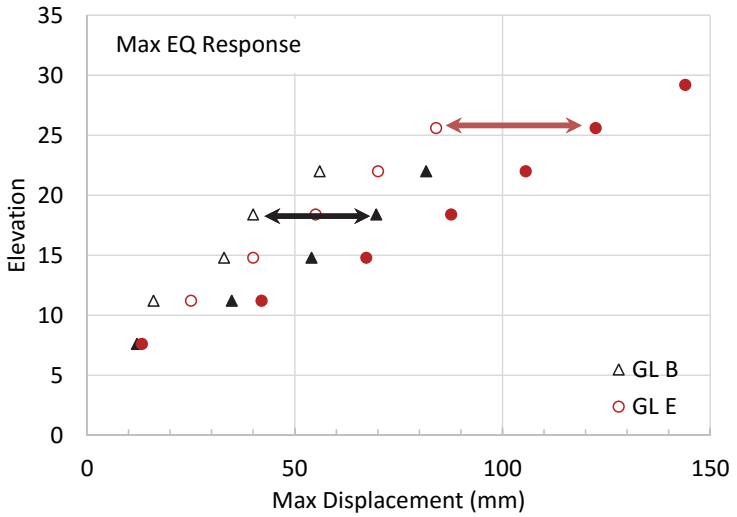


BUILDING OUTLINE

- 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

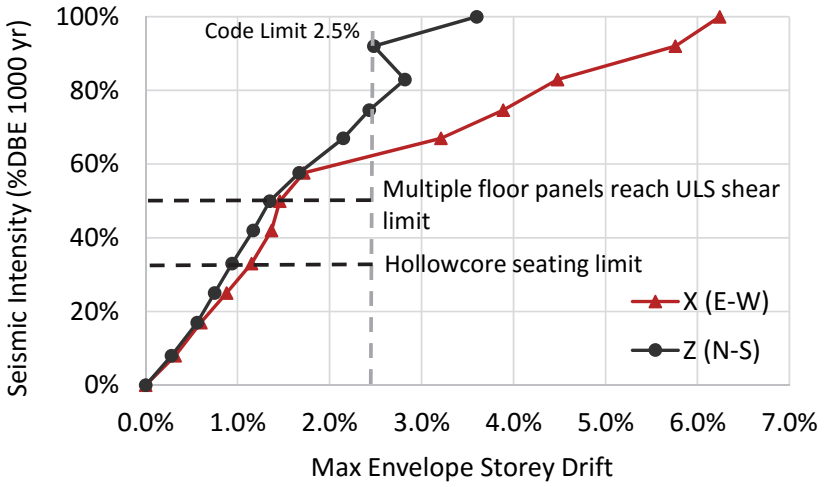


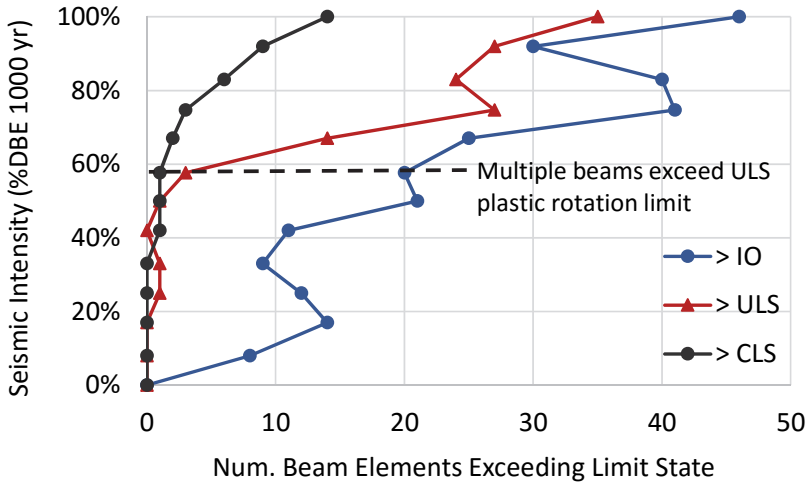
ASSESSMENT

- 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

ASSESSMENT

- IDA identified critical performance points





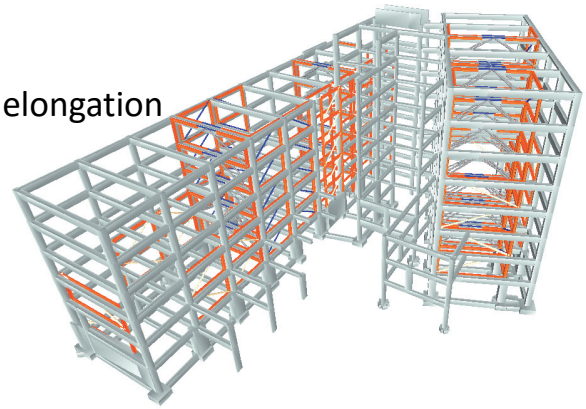
REPAIR TOWARDS RESILIENCY

- Pathway to the retrofit target

Increasing Owner discussion

Hollowcore seating collapse CLS	→	Install rectangular steel section 'catch ledges'
Core diaphragm strength	→	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 [α = 0.5] + BRB frames

- Limit existing frame ductility demand < 2.0 => frame elongation
- Maintain floor seating at DBE
- Limit BRB ductility < 3.0 => reduce potential residual drift



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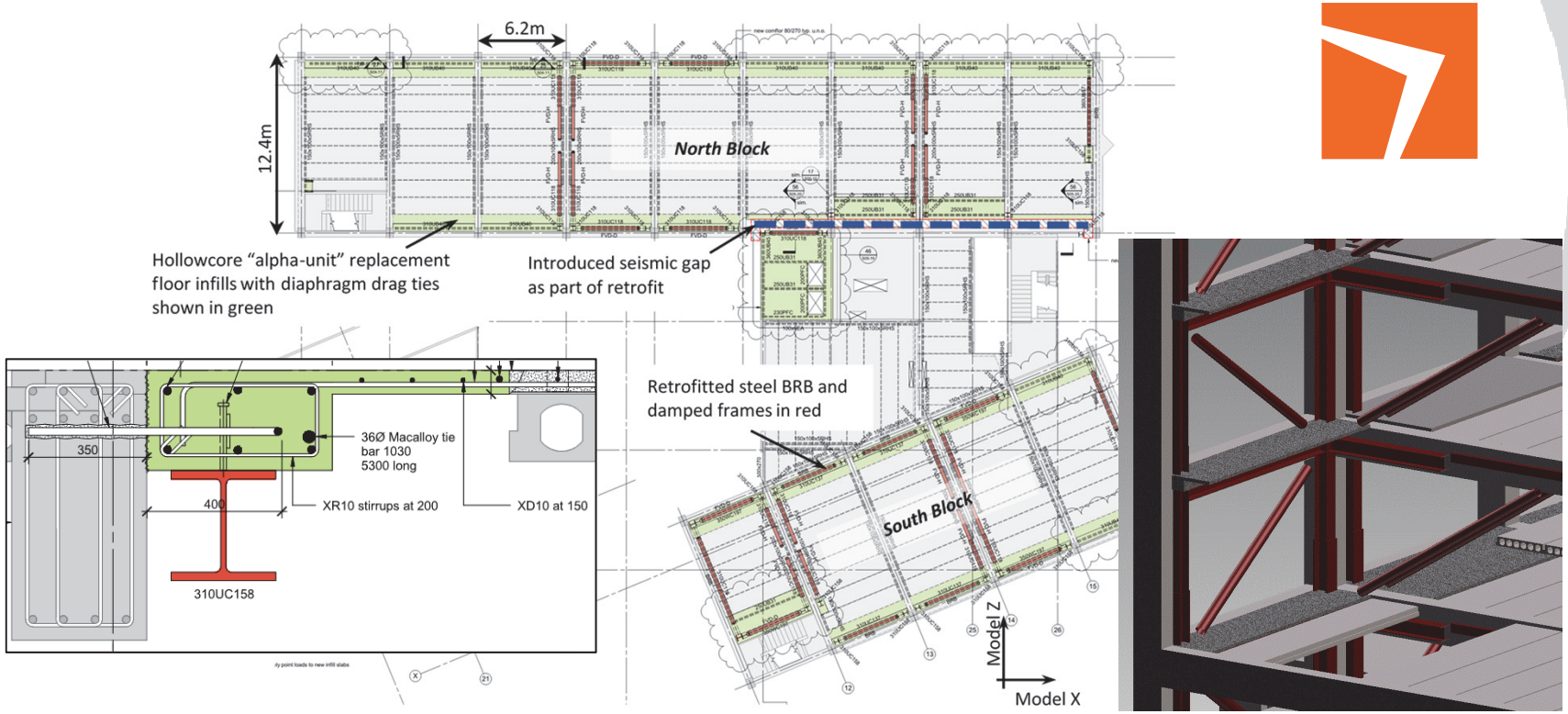
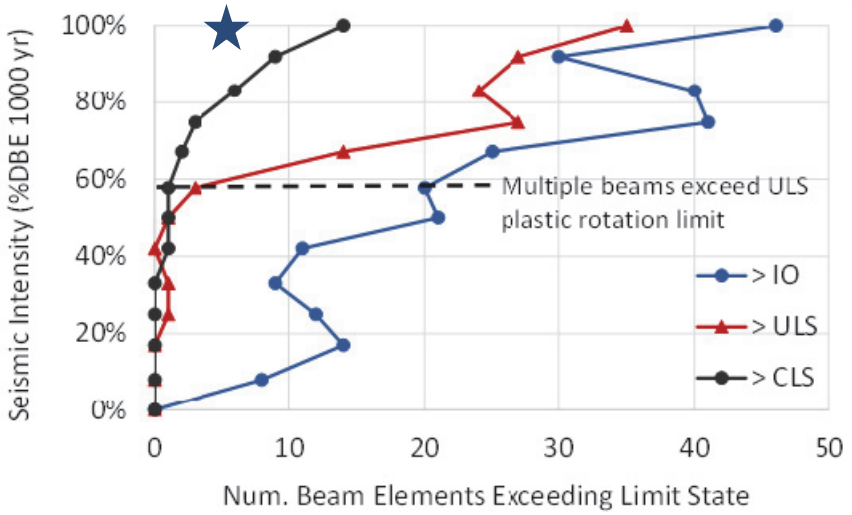


RESULTS

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?