Seismic behavior of rectangular cross-section reinforced concrete wall under high axial load

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Background

Reinforced concrete walls are normally used as lateral loading system in mid-rise and high-rise building.
Rectangular cross-section reinforced concrete wall was favored seismic resisting system in Chile and New Zealand. After the 2010 Chile earthquake and 2011 Christchurch earthquake, concerns about compression controlled flexural failure by concrete crushing and buckling of longitudinal reinforcement were raised.
Moreover, it was found that many reinforced concrete walls was under high axial load.

Fig. 1 Residential building in Chile

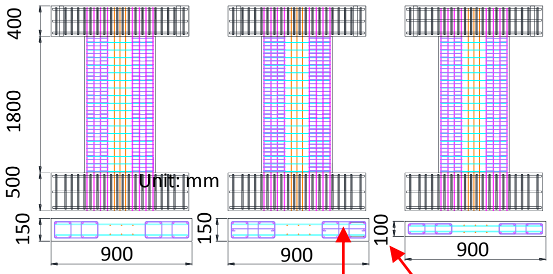
(a) (b)

Fig. 2 Flexure failure through concrete crushing and bar buckling/fracture: (a) the 2010 Chile earthquake and (b) 2011 Christchurch earthquake

Objectives

This experimental program aims to study flexure failure behavior and compare effects of tie-bar and wall thickness of rectangular cross-section RC walls under high axial load.

Specimens and Test setup



(a) N20A Bench Mark (b) N20T Add Tie-bar (c) S20 Thin Wall

Fig. 3 Specimens

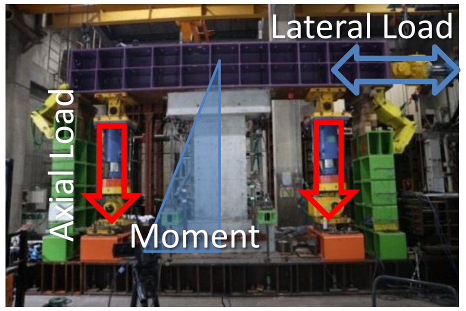


Fig. 4 Test setup

Specimens analysis and predicted failure mode

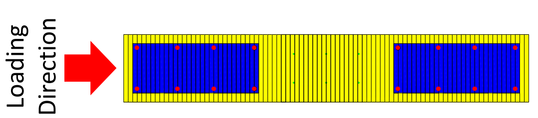


Fig. 5 Wall cross-section for analysis

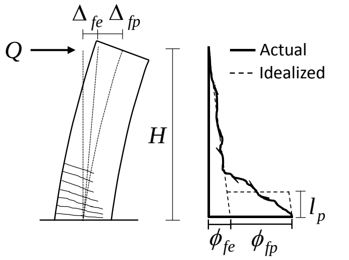


Fig. 6 Curvature distribution

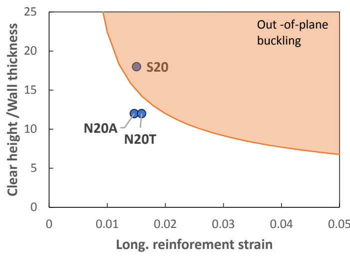
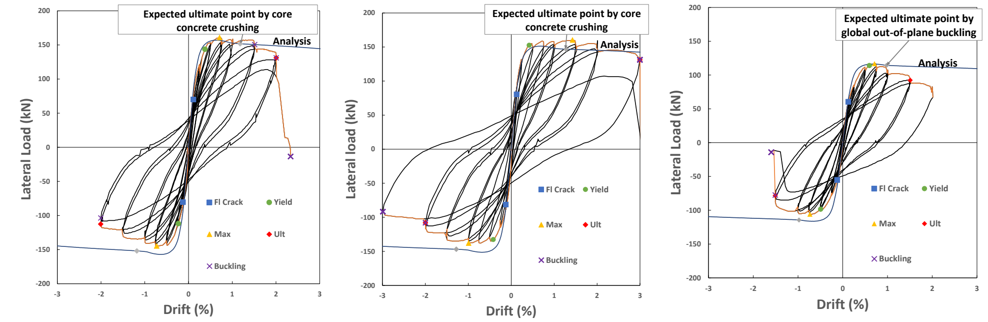


Fig. 7 Out-of-plane prediction

Results



(a) N20A (b) N20T (c) S20

Fig. 8 Relation of lateral load and drift : (a) N20A, (b) N20T, (c) S20

*Fl Crack = flexure crack, Yield = longitudinal rebar yield, Max = maximum load, Ult = ultimate was defined when load drop 20% of peak load

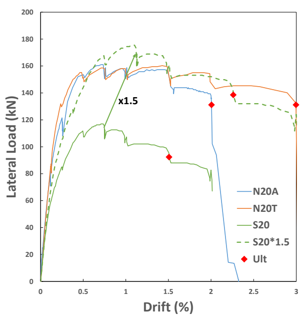


Fig. 9 Comparison of envelope curve

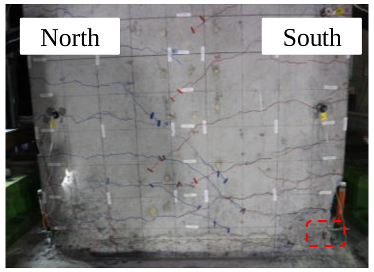


Fig. 10Damage of N20A including concrete crushing and rebar buckling

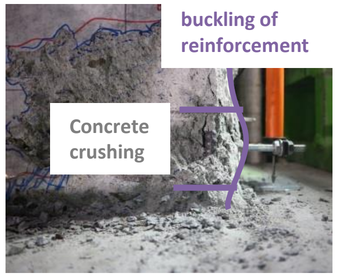


Fig. 11 Enlarge Damage of N20A

Fig. 8 and 9 show that N20T with adding tie-bar had lateral load similar to N20A, but larger ultimate drift capacity. S20 was expected to fail by out-of-plane buckling as shown in Fig. 8 (c). However, S20 was failed by concrete crushing same as N20A and N20T.

Figure 10 and 11 shows damage of N20A. Damage at failure point consist **of concrete crushing** at bottom corner of walls and **buckling of longitudinal reinforcement**

Conclusions

- Damages at failure point of rectangular cross-section RC wall under axial load of 0.2, include crushing at bottom corner of walls and buckling of longitudinal reinforcement
- Tie-bars improve the ultimate drift capacity of RC wall. Thin wall under high axial load failed by concrete crushing which was not the expected failure mode.

Contribution to Society

This work helps to understand flexure failure mode. Therefore, this kind of failure mode will be prevented in future earthquake.