**Effect of Loading Rate on the Response of Reinforced Concrete Prisms**

Qi Wang¹, Rick Henry², Lucas Hogan¹, Allan Scott²

¹ Department of Civil and Environmental Engineering, University of Auckland.
² Department of Civil and Natural Resources Engineering, University of Canterbury.

### Introduction

Research following the 2010-2011 Canterbury earthquakes investigated the minimum vertical reinforcement required in RC walls to generate well distributed cracking in the plastic hinge region. However, the influence of the loading sequence and rate has not been fully addressed. The new minimum vertical reinforcement limits in NZS 3101:2006 (Amendment 3) include consideration of the material strengths under dynamic load rates, but these provisions have not been validated at a member or system level. To investigate the effect of loading rate and sequence on the local behaviour of RC members, a total of fifteen axially loaded RC prisms with the designs representing the end region of RC walls will be tested under various loading rates.

The key objective of this test is to understand the local behaviour of RC members, including hysteretic load-deformation behaviour, crack patterns, failure mode, steel strain, strain rate and ductility. Recommendations will be made regarding the effect of loading rate and reinforcement content on the cracking behaviour and ductility of RC members.

### Experimental program

#### Prism description

Fifteen RC prisms with different vertical reinforcing ratios (0.23, 0.46, and 0.93%) and width (150 and 300mm) were designed for the experimental program. The prisms are intended to simulate boundary elements within flexure dominated RC walls. The wall designs are based on the Grid-F wall in the Gallery Apartments in Christchurch. Instead of basing the length of prisms on exactly 15% of prototype walls, the length of the tested prisms is defined as having a length extending from the extreme tension fibre to half the spacing of central unit area which is closest to the end region, resulting a length of 365mm for all prisms. The prisms are 1600 mm in height.

#### Loading protocols

This program includes pseudo-static and dynamic testing under monotonic and cyclic loading. Representative cyclic loading protocols will be derived from the results of inelastic time history analysis performed on a simplified prototype wall model and previous test data. The loading rate for slow, medium, and fast tests and their corresponding strain rates are listed in Table 2.

### Test setup

Specimens will be tested in the horizontal orientation for a simplicity of setup, as shown in Figure 4.

- A servo-controlled hydraulic actuator with the capacity of 330 kN will be used to apply the horizontal load to the prisms.
- The prisms will be clamped by two steel plates at each end using eight post-tensioning bars.
- A 5 mm thick gypsum plaster layer that can provide more effective friction interface will be used between the prism and steel plates.
- Two linear guideways with four blocks will be placed underneath the bottom plate of the extension arm.

### Instrumentation

Extensive instrumentation will be employed to capture the dynamic behaviour of prisms.

- Load cells, internal LVDTs
- Crack deformation relation
- String potentiometers
- Global deformation
- Portal gauges
- Local deformation, slip
- Noncontact photogrammetry instrumentation
- Distributed fibre optic sensors (FOS)
- Steel strain and strain rates

### Future work

This research is currently focused on evaluating the effect of loading rate on the local behaviour of RC walls through the testing of fifteen prisms, future work includes:

- Complete experimental tests on fifteen RC prisms, followed by a detailed analysis of test results.
- Provide data for validation of prism models estimating the local bond and cracking behaviour of limited ductile walls.
- Conduct reinforcing steel tests to support the findings of prism tests regarding the bar post-buckling fracture behaviour.

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