FITZGERALD AVE
RETAINING WALL EARTHQUAKE DAMAGE

Presentation to
REAAA NZ Chapter
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Site Locality Plan

- Fitzgerald Ave – 4 lane arterial
- 30,000 VPD
Site Locality Plan

- Fitzgerald Ave – 4 lane arterial
- 30,000 VPD
Canterbury Earthquake Sequence

Seismicity to 4th June, 2012

Sub-surface fault rupture
Greendale Fault
Active faults
Seismograph Records - CBD

Christchurch Catholic Cathedral College

PGA = 0.2g
PGA = 0.8g
Canterbury Plains Geology
Feb 2011 Earthquake Damage

• 4 Lane Arterial Road over 260 m length
  ➢ Outer 2 lanes - Major cracking 1.2m wide and 1.2m deep.
  ➢ Inner 2 lanes - distorted but used for temporary 2 way flow

• Previous 3m high retaining wall Below Road
  ➢ Severe lateral spreading - 1.5m sideways
  ➢ settled vertically up to 0.5m
  ➢ Differential movement caused structural damage
Road Damage

1.5m
Road Damage

- Inner lanes - Moderate damage but used for temporary 2-way flow

- Outer 2 lanes - Severe Damage
  Cracks 1.2m wide, 1.5m deep
Wall Damage
Project Set Up

• Client: Christchurch City Council (IRM0 & SCIRT)
• Alliance: EDI Downer & OPUS
• Opus involvement:
  ➢ Initial Appraisal & Option Development
  ➢ Site Investigations (6 CPTs, 2 Boreholes)
  ➢ Design Report
  ➢ Design drawings and specification
  ➢ Construction Monitoring
  ➢ Construction June 2011 to Oct 2012
Ground Profile

- **Simplified profile**
  - 1.0 m of sandy gravel fill, over
  - 4.0 m loose to medium dense fine sand/silt (Liquefiable)
  - 3.0 m of medium dense to dense sandy gravel,
  - 15.0 m of medium dense sand (top 3 m Liquefiable)

- **Groundwater**
  - Gwl = River level, (about 4 m below Road)
  - River level tidal (0.5 m)
Repair Objectives

• **Stone Columns**
  - improve founding for wall units
  - Provide lateral spread resilience

• **Deformation tolerant solution:**
  - Segmental 1.5m long reinforced concrete “L” Units
  - Attached to geo-grid reinforced fill
  - Allow 200mm of deformation in (ULS) earthquake
  - Road useable with minimal repair
Repair Concept
Stability Analysis
Ground Improvement Details

• Stone Columns
  ➢ 500 stone columns, 600 diam to 10m depth
  ➢ Initial spacing 1.6m, 4 columns wide
  ➢ Column fill – low fines crushed AP35 (drainage metal)
  ➢ Target Guide CPT tip resistance Qc = 13Mpa.

• Innovative Displacement Auger Method:
  ➢ Casing insertion & auger densifies ground
  ➢ Well graded fill provides filtration & drainage element
  ➢ Dry method, good work platform & negligible silt run-off.
  ➢ Minimal Environmental effects – vibration-less and quiet

• First Time Method Used » » Needed a Trial!!
Stone Columns Trial

• 1.6m, 1.8 & 2m spacings trialed

• 1.4m spacing adopted
Stone Column Installation

- Inserted stone volume >1.5 x casing volume i.e. stone diam. 100 mm larger
- Well graded Gravel fill - for compaction and filtration
Construction Site
Precast Wall Facing

- Temporary props and blocks
- Geogrid tails cast in
- “L” Unit base cast in situ
- Filter fabric wrapped drainage blanket with geogrids
L Unit Wall After Base Poured

- bars for kerb/guard rail beam
- Geogrid tails cast in
- Geogrids attached to ‘L’ Unit base
Geogrid Reinforced Fill

- Geogrids Tensar RE580
- Bodkin joints to tail inserts in wall
- Filter fabric wrapped drainage blanket

- CCC AP65 fill
- 200mm layers
- 95% of MDD
Pavement – North Bound (Outer) lanes

- Subgrade thick geogrid reinforced granular fill
- 180mm TNZ M/4 AP40
- 40mm AC Mix 10 (over Grade 4 chipseal)
Pavement - Subgrade South End

- soft clay/silt & saturated
- Adjusted design
  - filter fabric layer on top
    300mm working platform
  - Weakest section top
    150mm cement stabilised
  - 2 layers triaxial geogrid in
    520mm CCC AP65
  - 180mm TNZ M/4 AP40
Road Surfacing

- 40mm AC Mix 10, over
- Grade 4 chip seal
Footpath Concept

- Robust “Wharf Like” Look
- Deformation Tolerant
- Easy to repair
- Light weight
  - Timber deck
  - Gritted paint surfacing
Footpath

- Outer bearers 250x150 Steel RHS
- Cross beams 125mm PFC’s
- Cross beams cantilever over bearers
- Timber longitudinal stringer beams

- Timber decking
- Steel posts
- Timber post surrounds
Finished Footpath

- Guard rail & cyclist protection
- Posts attached to cast in-situ kerb/beam
- Footpath handrail and fencing fixed to timber post surrounds
The Finished Product