NS) OPUS

Ex Tropical Cyclone Fehi 1 February 2018

Punakaiki State Highway during the cyclone



Introduction

OPUS

The West Coast Region extends from -

National Park

Glacie

Twizel

- Kahurangi Point in the North to
- Awarua Point in the South





Auckland to Wellington 649km

Νοπη

600 km in length from point to point •

ational Pa

wizel

- Tasman Sea to the West
- Southern Alps to the East

Cyclone Fehi walloped the West Coast the entire 600km length simultaneously

Takaka Paraparaumu Kahurangi National Park Nelson Wellington Picton Blenheim Westport Punakaiki Greymouth Hanmer Kaikoura Springs Hokitika Franz Jose Rangiora Christchurch Akaroa Ashburton Tekapo Geraldine Timaru

Punakaiki 2017

Source: WSP Opus



Punakaiki State Highway during the cyclone

Inundation and debris forced temporary closures of sections of the State Highway network



Initial Response by Network Outcome Contract (NoC) Contractors reinstated the highway to one lane



Coastal Team

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Photograph: Ana Serrano and Greg Saul standing in what is left of Punakaiki's seawall after Cyclone Fehi (February 2018)





- Safe to drive?
- Spray/overtopping
- Aquaplaning



- What about at night?
- Guardrail
- Pavement damage

Vehicle safety

- Road closures
- Storm/flood warnings
- Aquaplaning/drainage
- Spray
- Debris
- Damage to carriage way

Roading assets

Vehicle safety

- Road closures
- Storm/flood warnings
- Aquaplaning/drainage
- Spray
- Debris
- Damage to carriageway

Roading assets

Pedestrian safety

- Access to foreshore
- Access to cavern
- Pedestrian crossing
- Road layout
- Road signage and markings

Maintenance activities

Inspection

Seawall/revetment

- Top-up/re-arrange rock
- Vegetation management
- Upper slope treatment
- Toe & crest repair

Maintenance activities

- Inspection
- Top-up/re-arrange rock
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Seawall/revetment

- Design criteria
- Damage factors
- Access arrangements
- Crest height
- Toe detail
- Extent & terminations
- Overtopping rates

Considerations

- Static & dynamic load case
- Drainage
- Surface treatment (seaward of wall)
- Connection to vehicle restraint system

Retaining wall

Seismic design?

Community

Considerations

Environment ·

- Connectivity
- Temporary disruption
- Connection to adjacent community infrastructure
- Opportunity for enhancements?
- Reinstatement



Design Philosophy

- Return highway to pre-Fehi condition
- Provide coastal erosion risk management solution to a standard that prevents significant damage to pavement in a similar future storm
- Maintain pedestrian access to cavern and beach
- Protect all road users from any hazards introduced as part of the reinstatement works – clear zones



Design details

- Toe detail for resilience to future foreshore lowering
- Geotextile and granular protection layer for longevity/stability
- Drainage for overtopping, spray, rainfall runoff
- Crest level and upper slope treatment

3d Severe scour potential - no excavation

The armourstone toe is placed directly on to beach with toe width equal to $3y_s$; see Figure 6.64. There is no excavation, but the toe contains sufficient material to create a falling apron, which lines the face of the scour hole that is created. Where a geotextile is used, a Dutch toe detail may be adopted, with the geotextile wrapped around the toe stone. This form of toe is commonly used with underlayers in conditions where construction is in the wet, although sometimes it is impractical to use a geotextile in these conditions.

Advantages:

- simple construction, relatively easy to maintain
- avoids the need for excavation.

Disadvantages:

localised scour holes will occur around toe armour stones.



Figure 6.64 Toe detail 3d: severe scour potential - no excavation

ketch of falling apron/toe design



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Plan form

- Terminations
- Access
- Drainage
- Clearways & edge protection



wsp

• Granite

- 4,500kg
- Angular/blocky
- ~85kms from site



Sandstone

3,000kgAngular/blocky

~30kms from site

A Mile Quarry

wsp

- AVAILABILITY
- SIZE
- SHAPE
- **DURABILITY**
- MAINTENANCE
- HAULAGE

• COST

Photographs: Typical rock mass structure and typical large amour stone boulder used for testing and showing common dykes



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Photograph: Typical large armour stone boulder used for testing

MATERIALS TESTING

- Quarry
 - Petrographic inspection
 - Grading
 - Shape
 - Drop test
- Laboratory
 - Water absorption
 - Density
 - Compressive strength
 - LA Abrasion
 - MgSO₄







Key Planning Learnings

Early consultation with Key Stakeholders

- Council's
- Department of Conservation
- Local Community

Even if you cant provide a forward plan - - - establish points of contact

- Form early relationships
- Provide surety that their interests are being considered



Project Meetings/ Workshops Be part of the project team from the onset Attend project meeting

- Your input is valuable
- Highlight environmental considerations/ requirements early



Summary

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- Discuss levels of service to ensure solutions meet needs of project stakeholders
- Review design parameters as design and construction progresses
- Use calculation outputs to facilitate meaningful conversations about how structure is intended to perform and the nature of residual risks
- Use design guidance (CIRIA Rock Manual, NZTA Bridge Manual, MFE Climate Change Guidance) at project team meetings to explain design decisions and implications for operation and maintenance.
- There is more that one way to design coastal infrastructure. By discussing levels of service and residual risk we can deliver effective and efficient designs and safely construct and operate our coastal infrastructure.

