Liquefaction Performance of Wellington Reclamations

Insights from liquefaction analyses based on simplified, laboratory, and advanced methods

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UNIVERSITY OF CANTERBURY
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CHRISTCHURCH NEW ZEALAND

QuakeCoRE Monthly Meeting
Disciplinary Theme 1
Thursday, 2 November 2023

Overview

- Wellington Port Background
- Site Characterization
- Liquefaction Assessment
  - Simplified Methods
  - Laboratory Studies
  - Numerical Modelling
- Concluding Remarks

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Wellington Port Background

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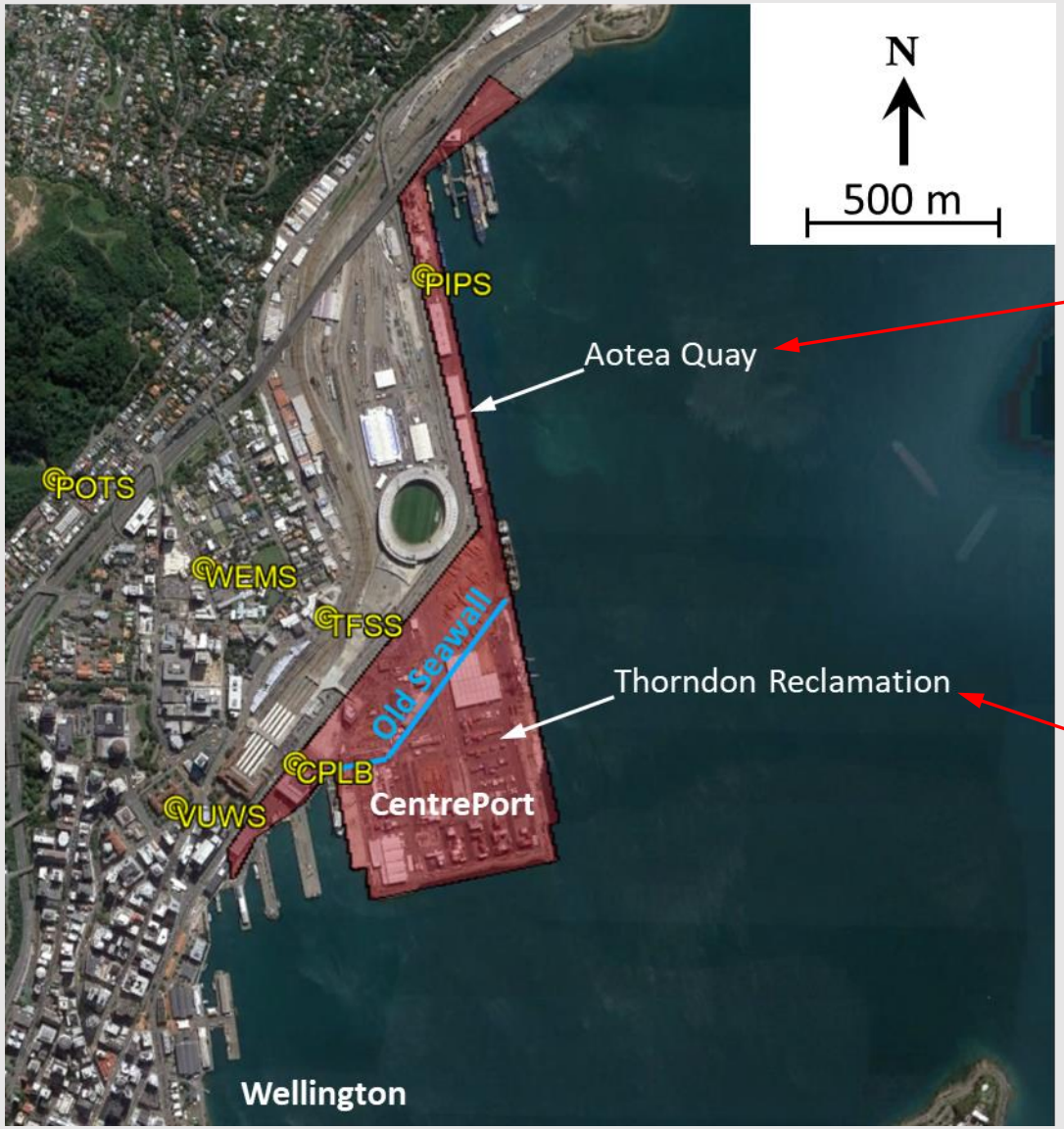
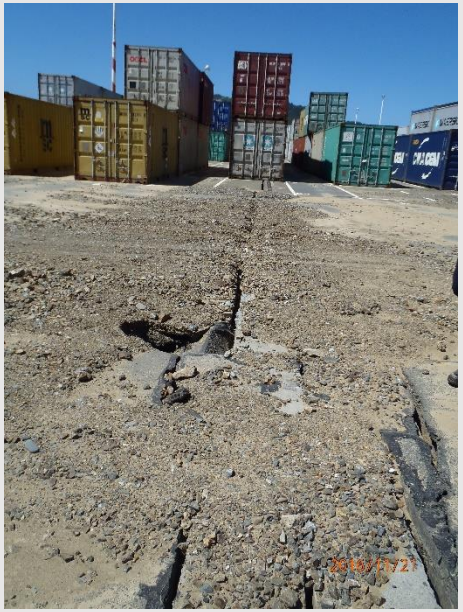
CentrePort Case History



Liquefaction Damage from M_w7.8 Earthquake

Thick ejecta
(up to 200 mm)



Settlement of fill
(up to 500 mm)

Damage to Thorndon and King's wharf piles and deck
(severe)

PGA ≈ 0.20g – 0.31g

2016 Kaikoura: Major damage

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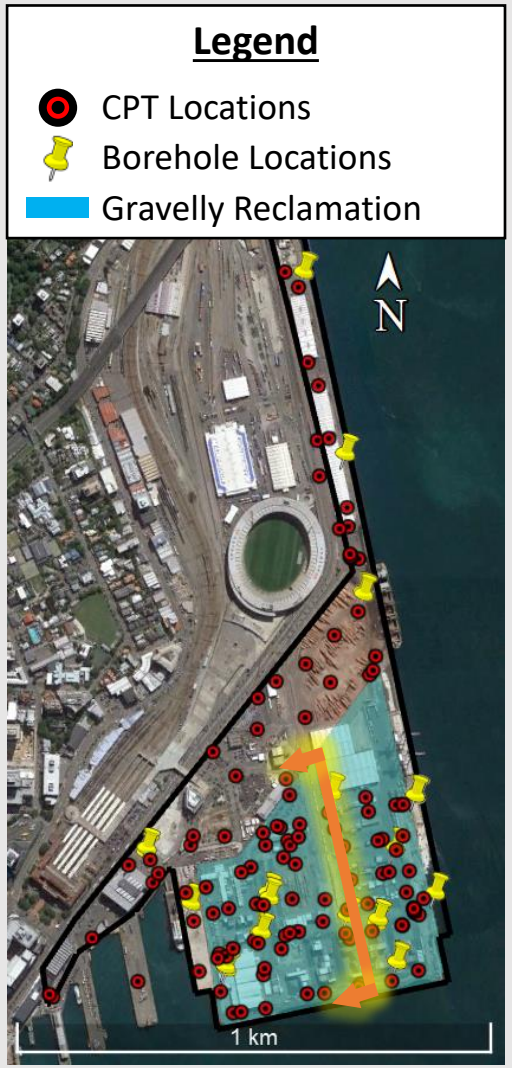
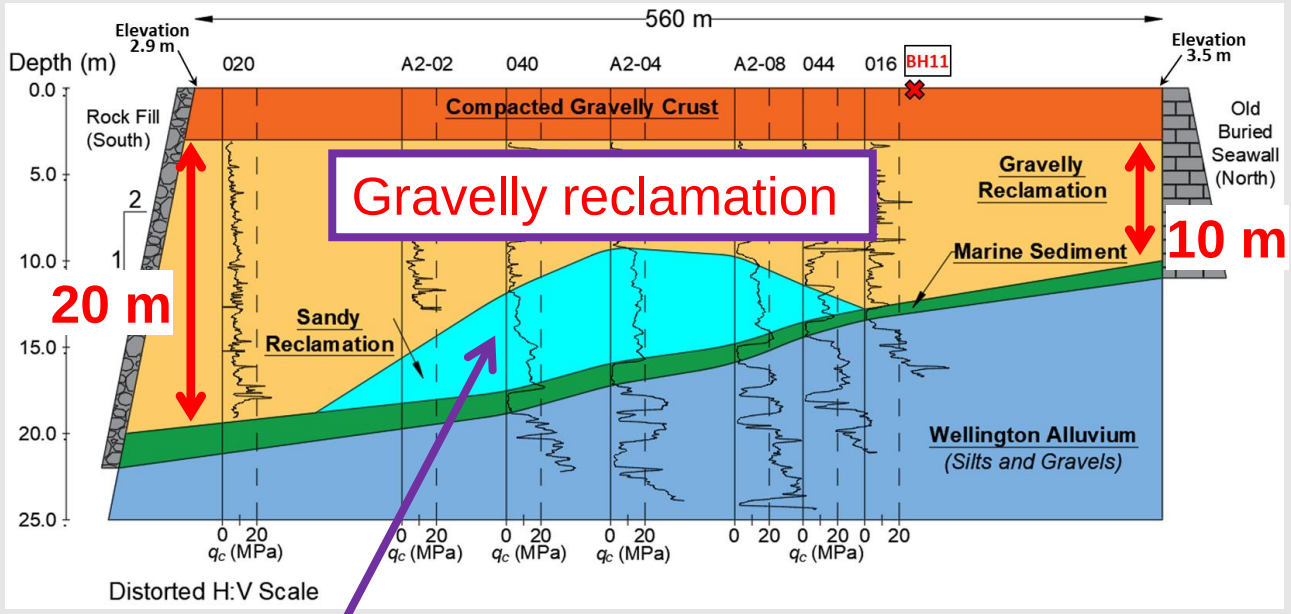
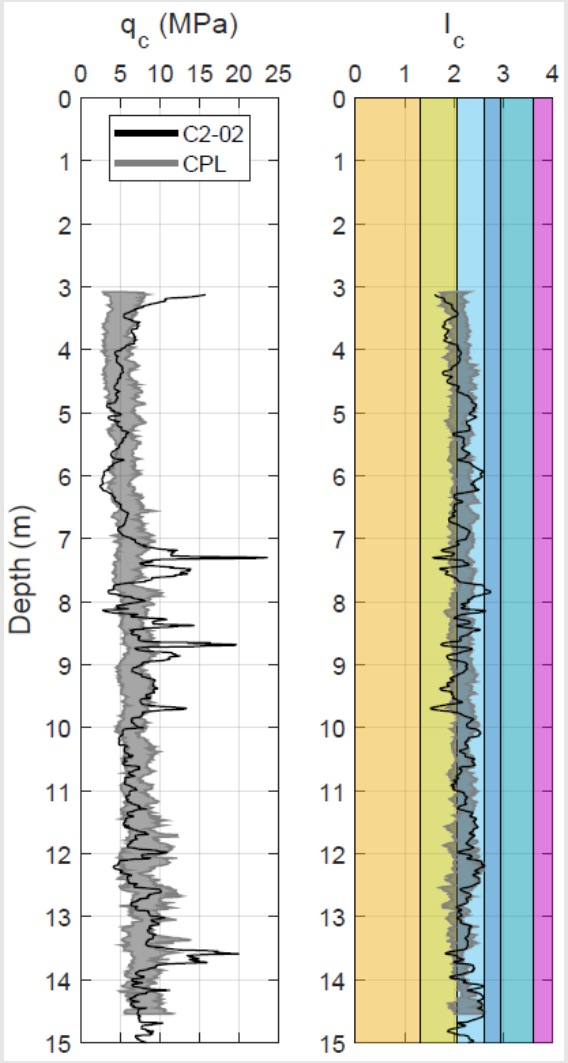
Site Characterization





- I_c = 1.9 – 2.3
- q_c = 6.5 – 8.0 MPa
- Sand-silt controlled matrix
- Indicates performance during Kaikoura EQ



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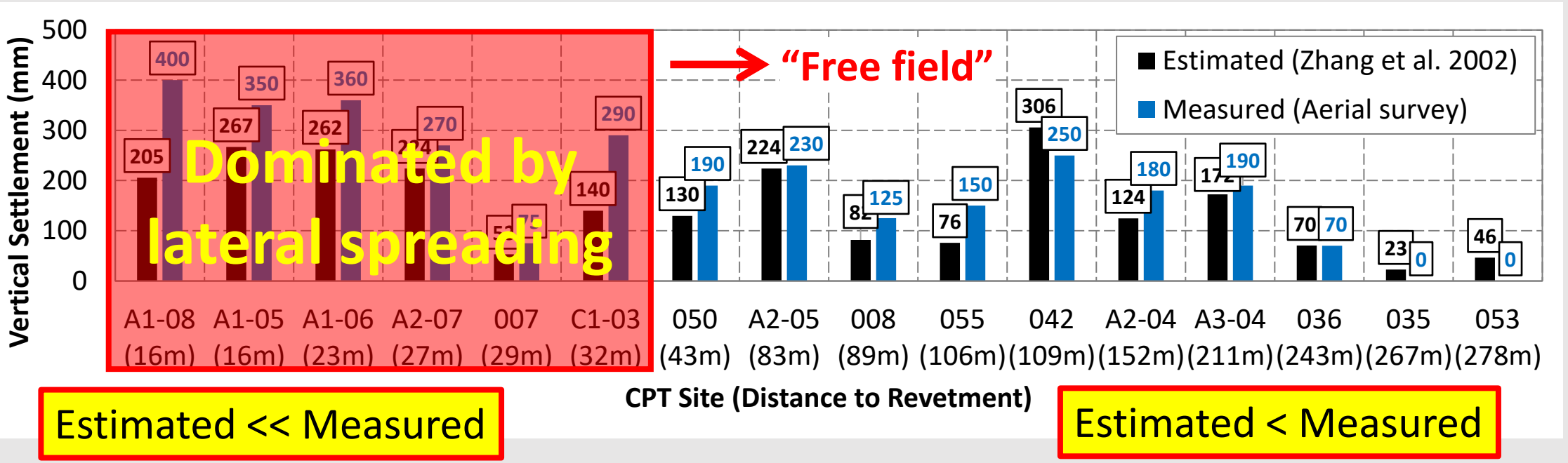
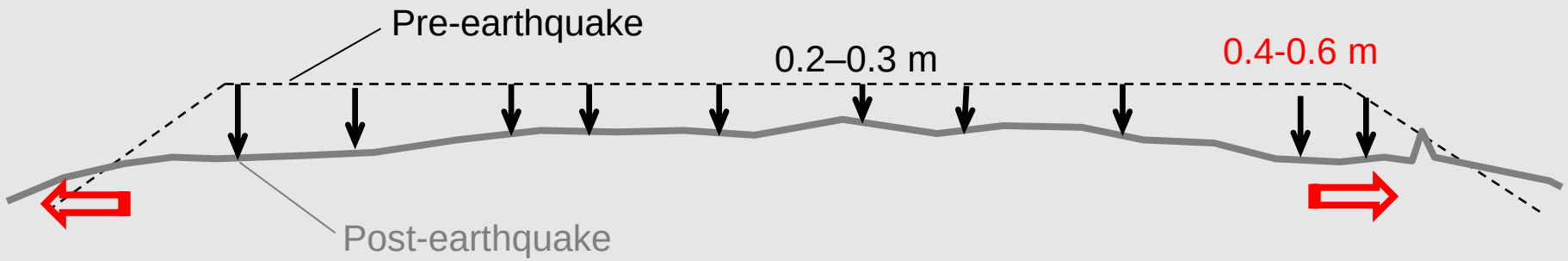
Performance of Damage Indices





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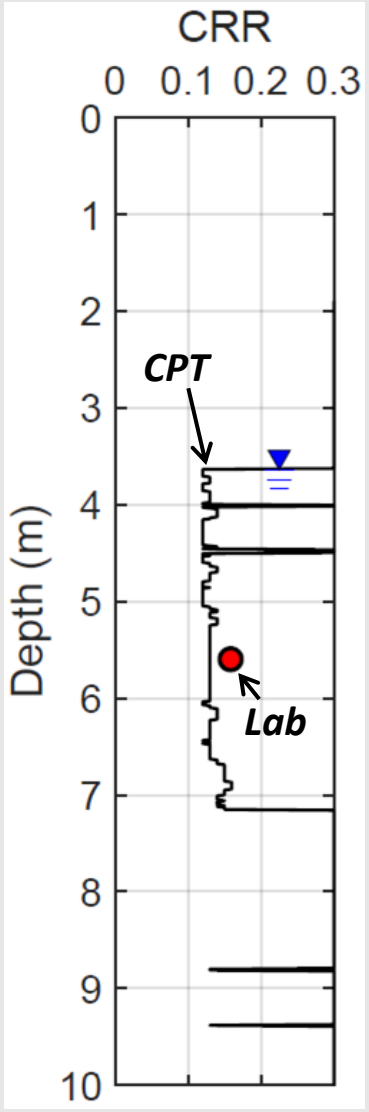
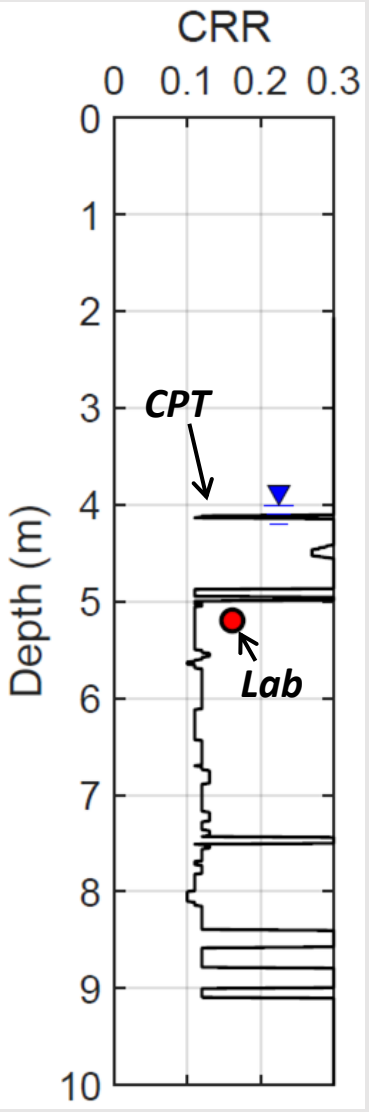
Laboratory Cyclic Testing

Sandy fill ($I_c \approx 2.0$)
AQS3A-1 GPTR1B



Shelly fill ($I_c \approx 2.0$)
AQS1A-2 GPTR2C



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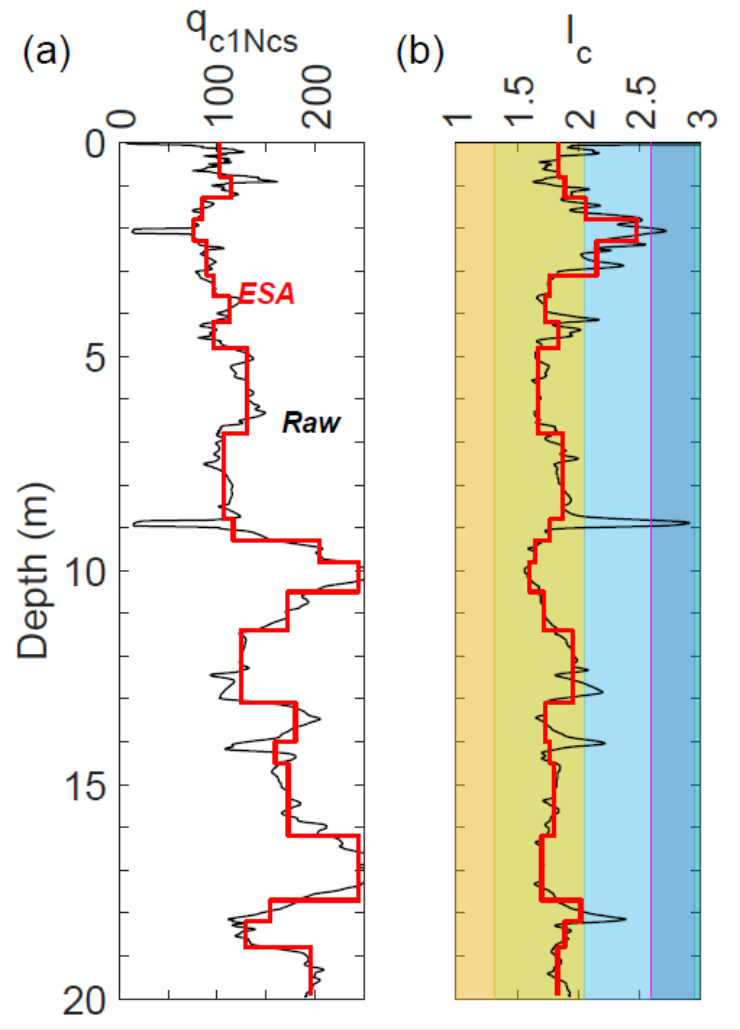
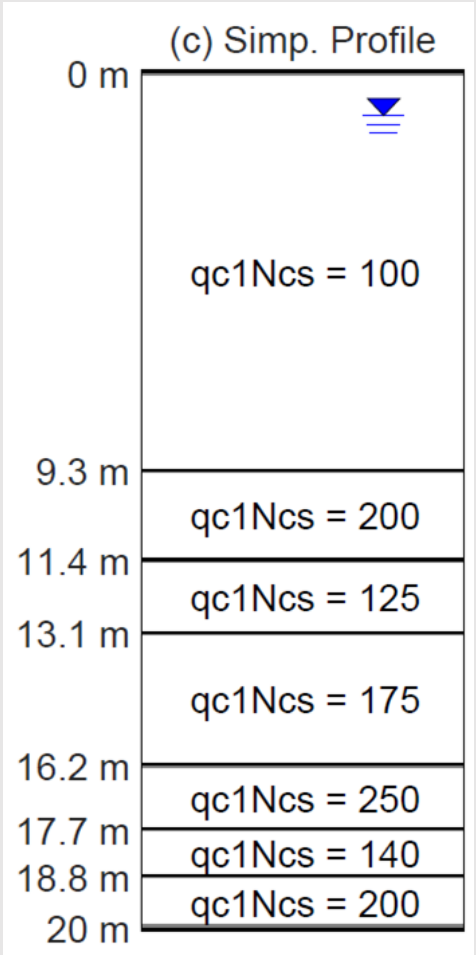
1D Effective Stress Analyses

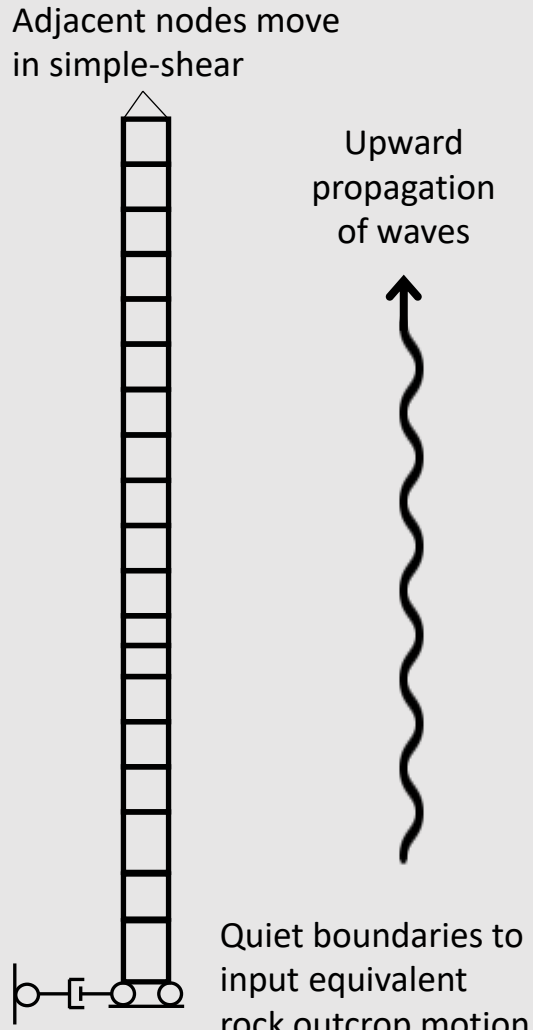
CPT data → Simplified profile algorithm



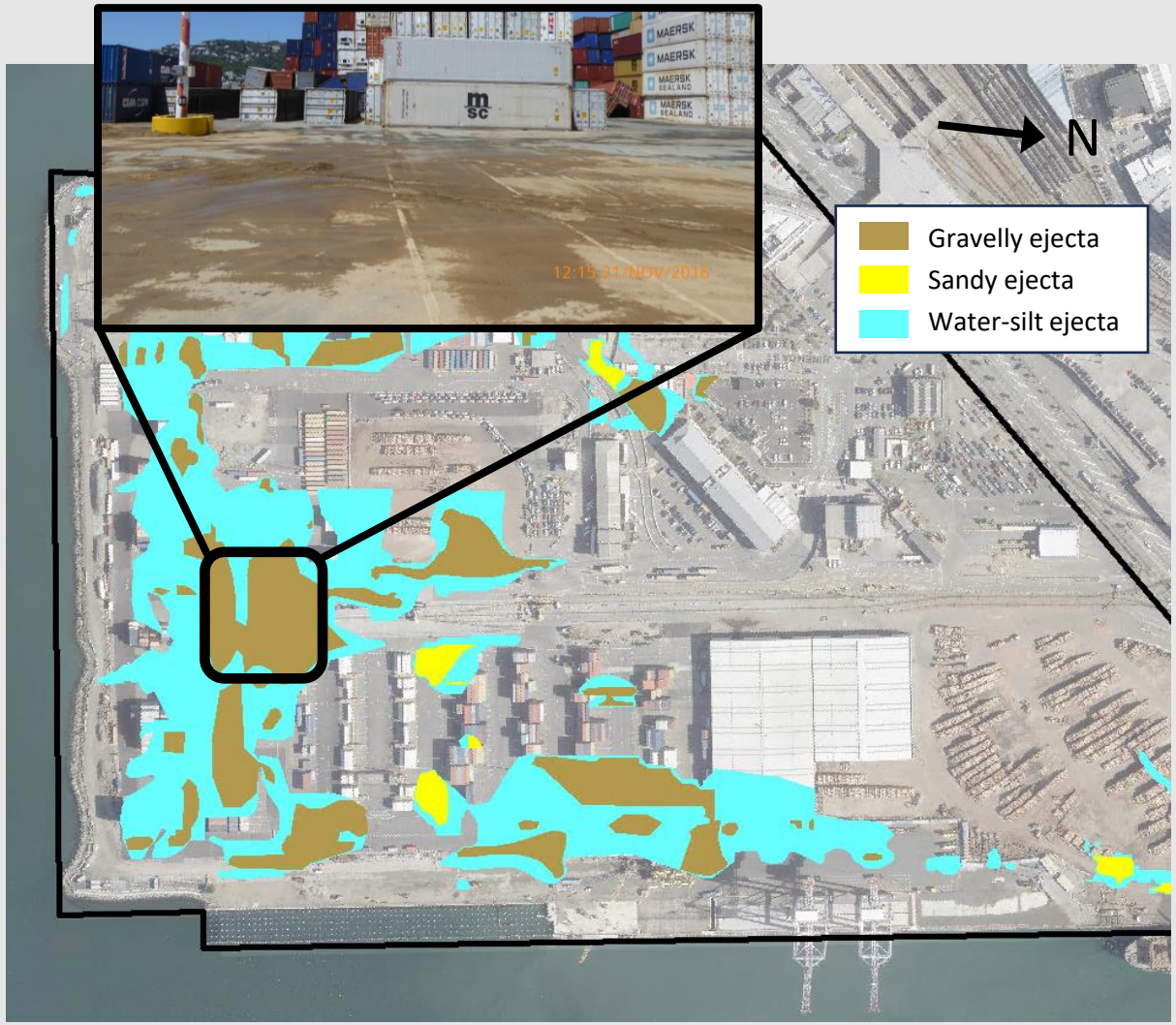
Simplified profile

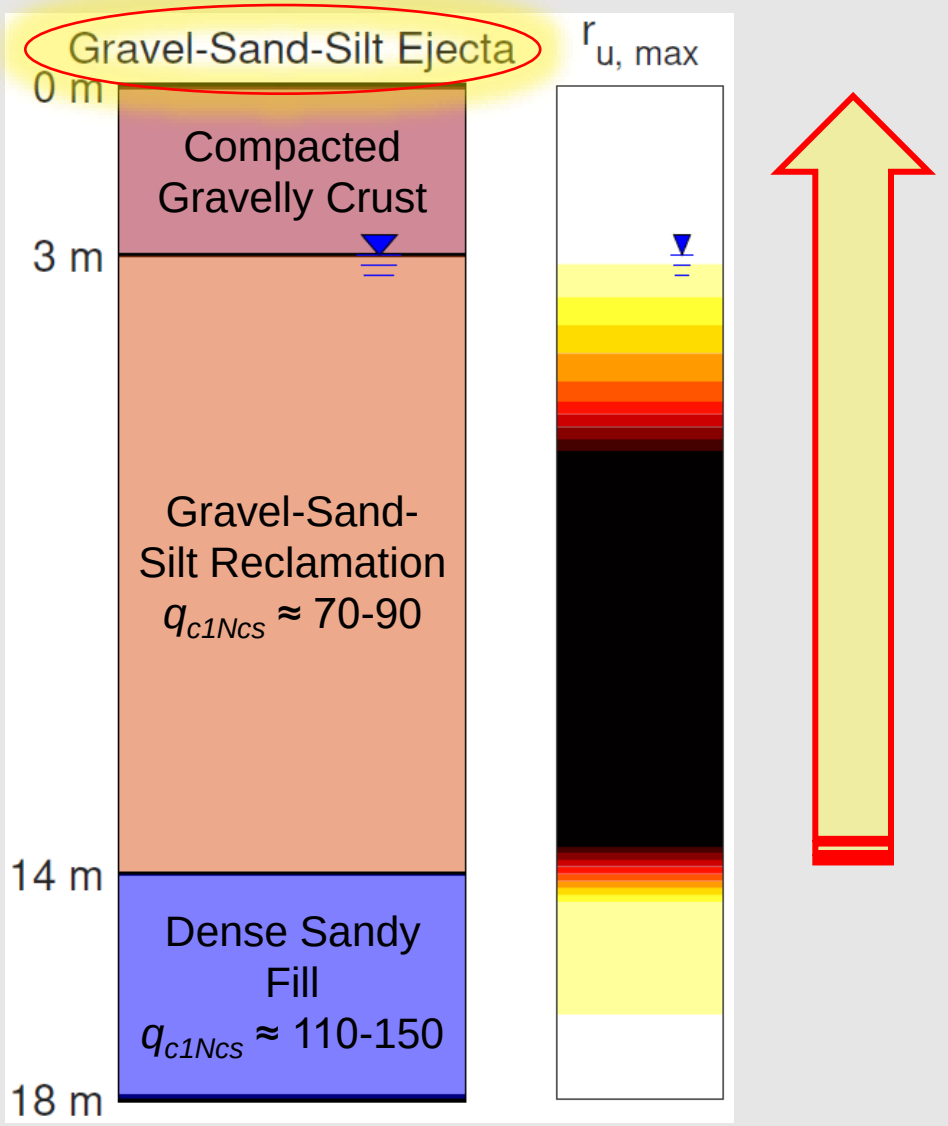


Numerical model



1D Effective Stress Analyses





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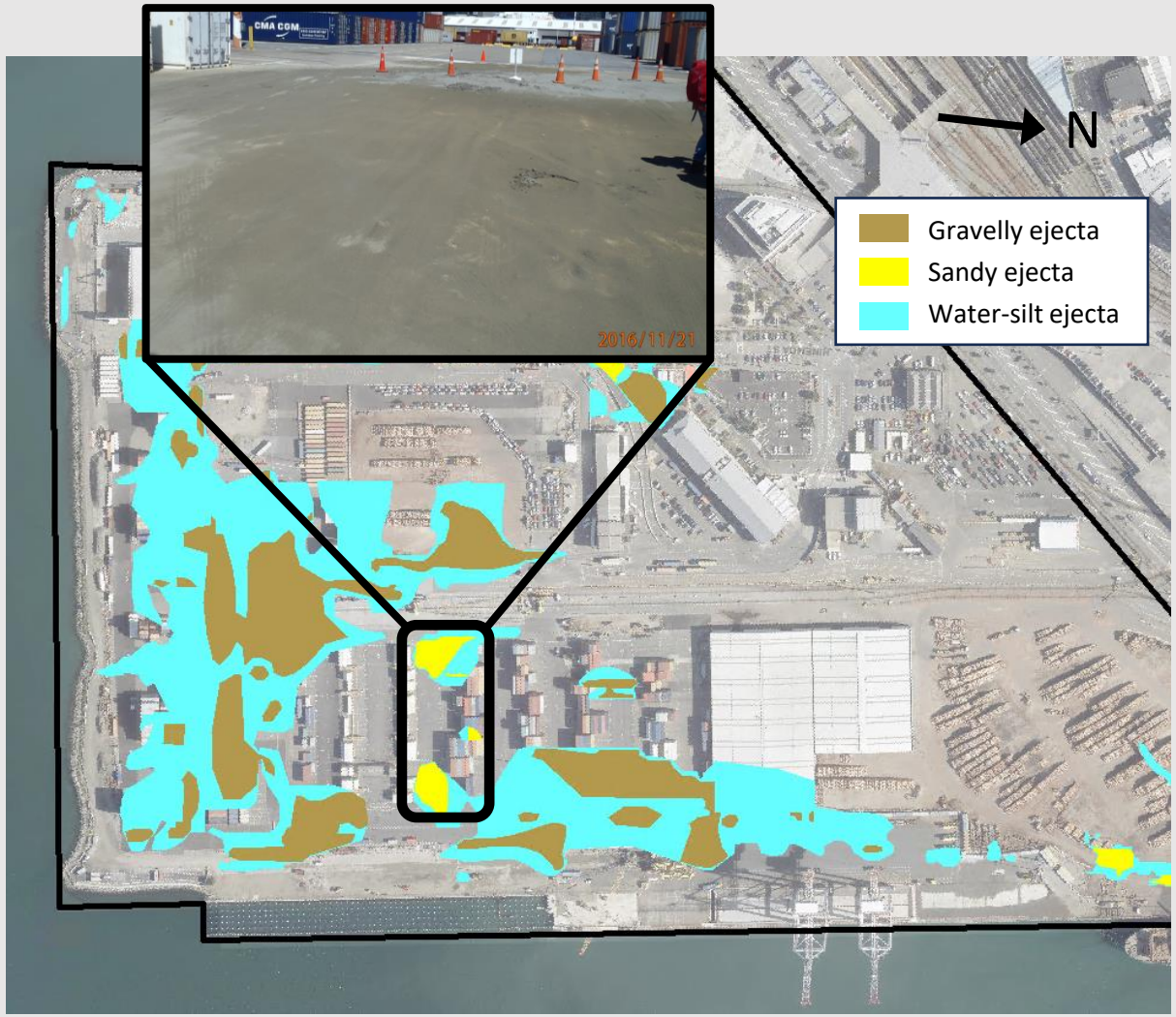

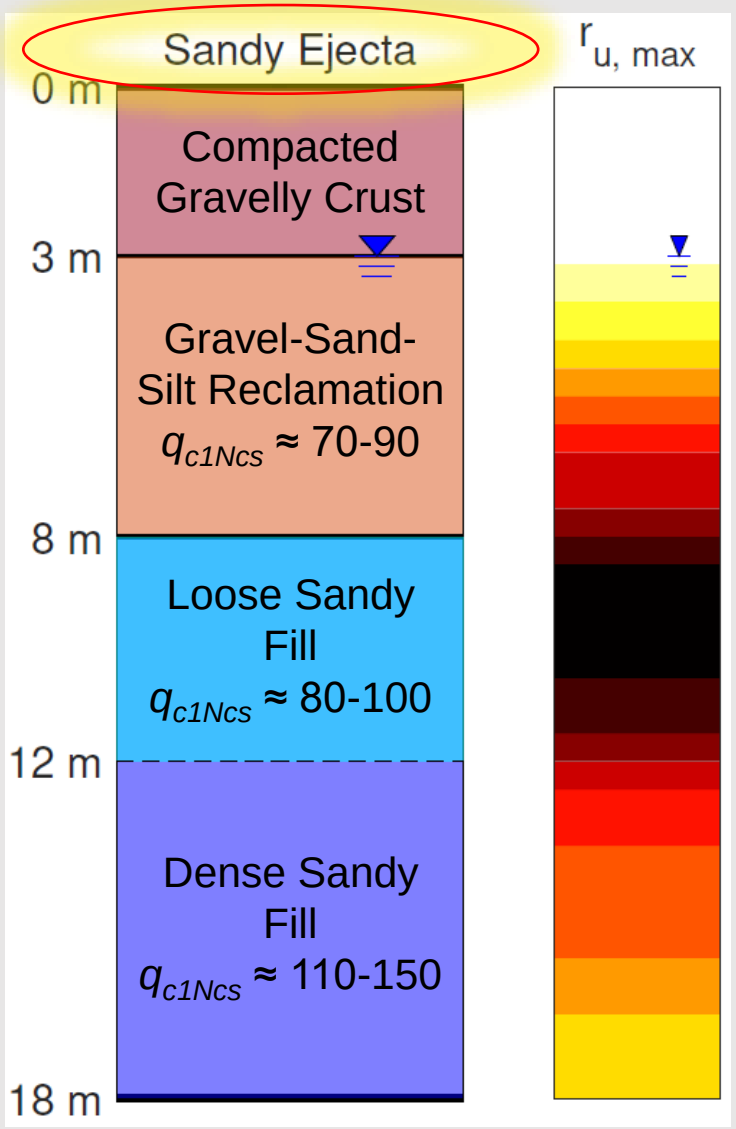

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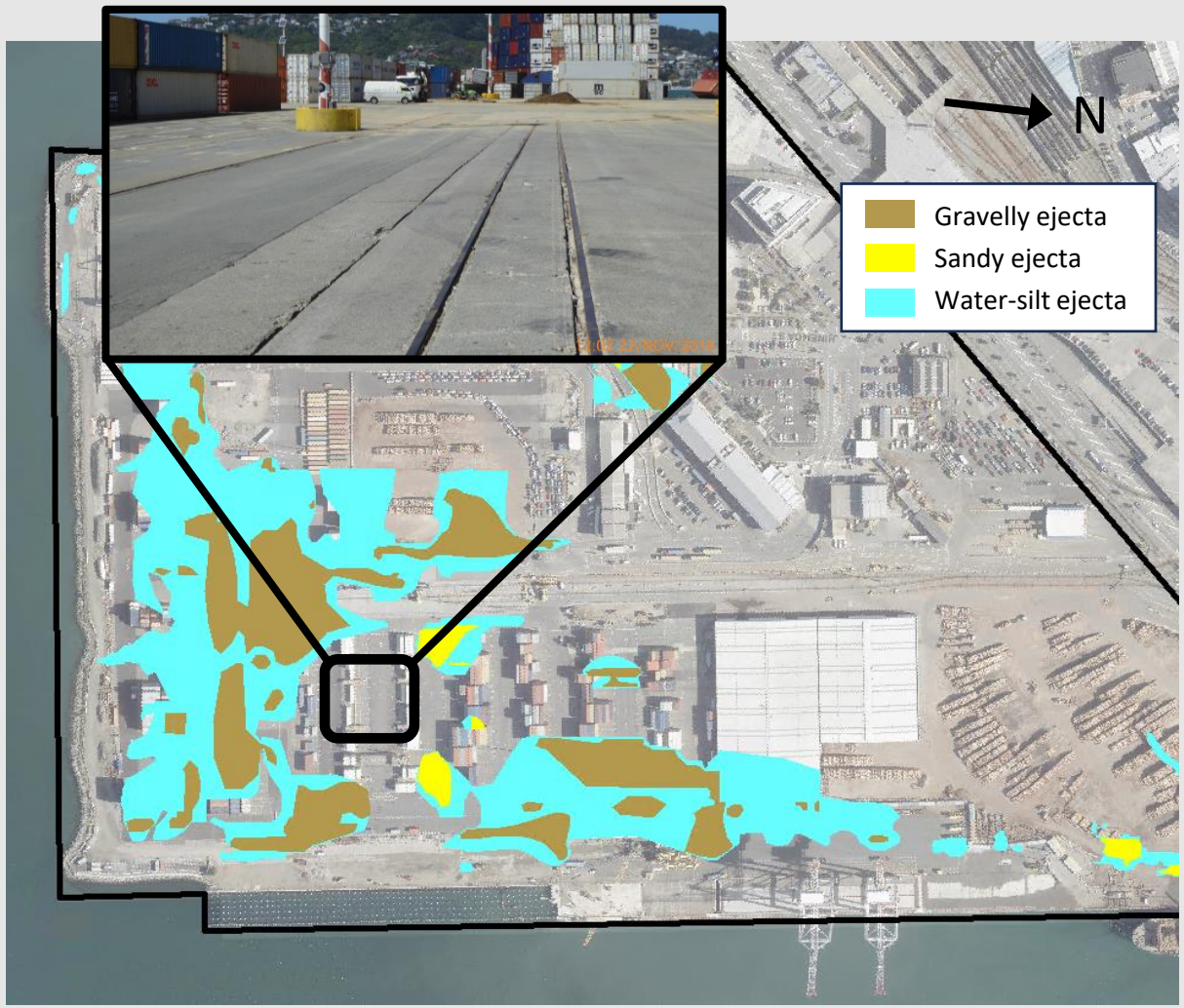
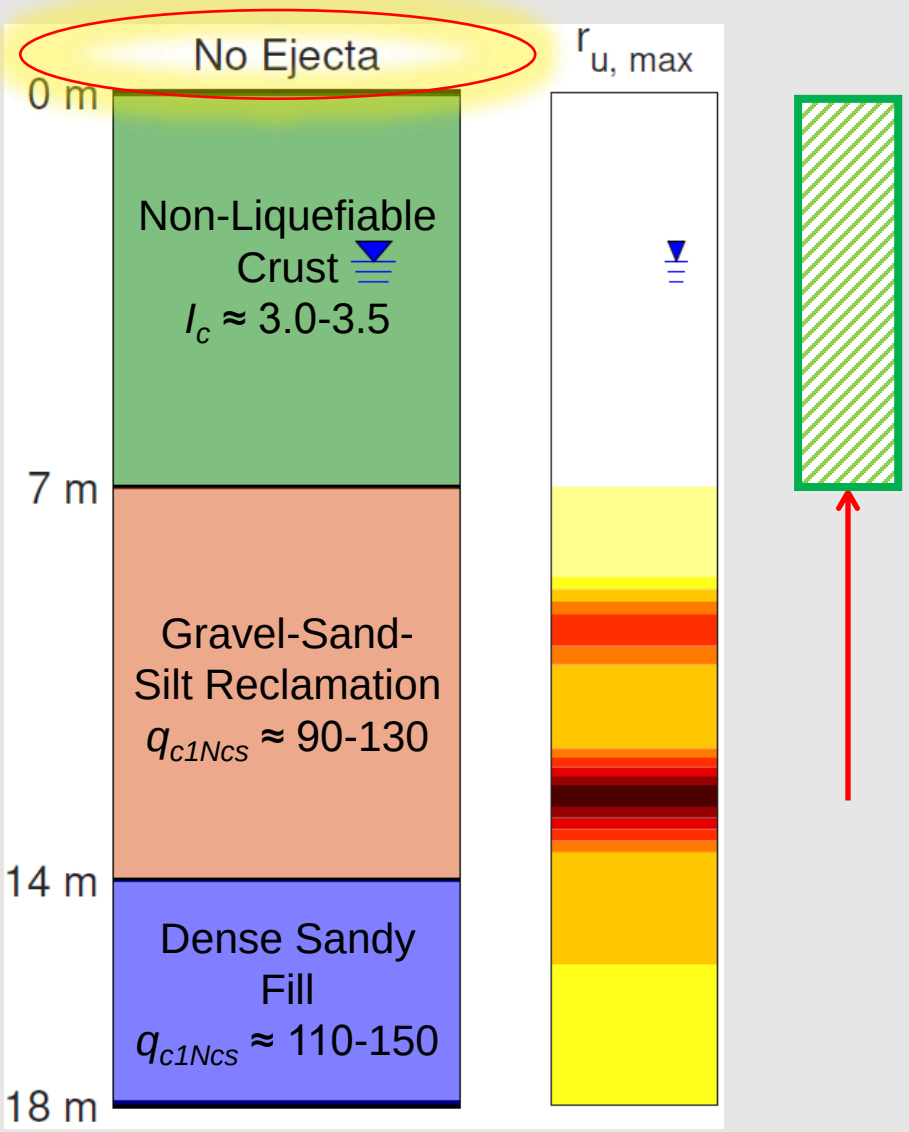
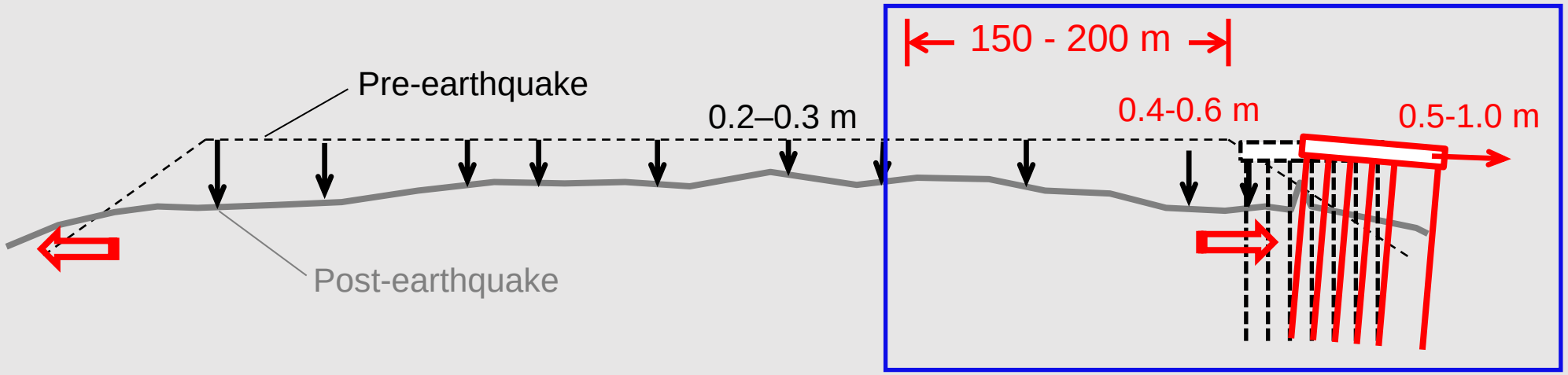
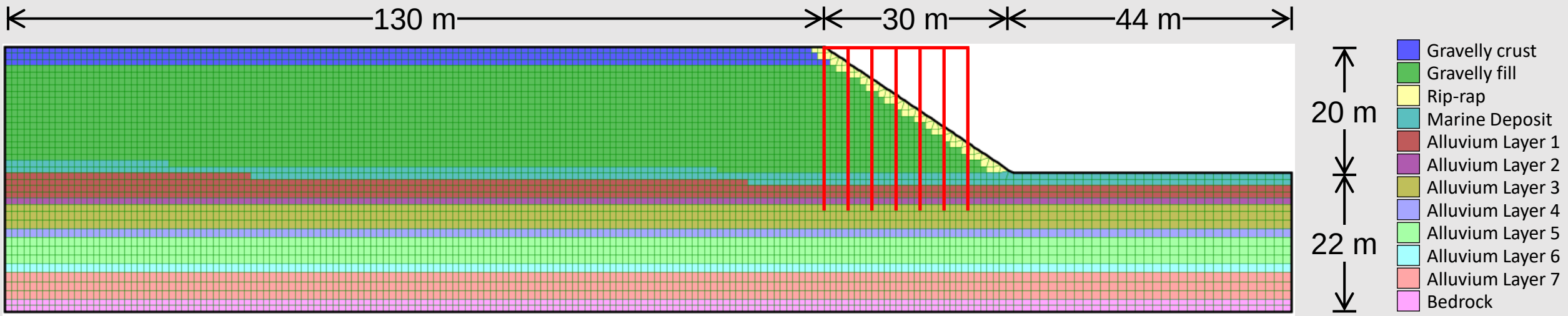




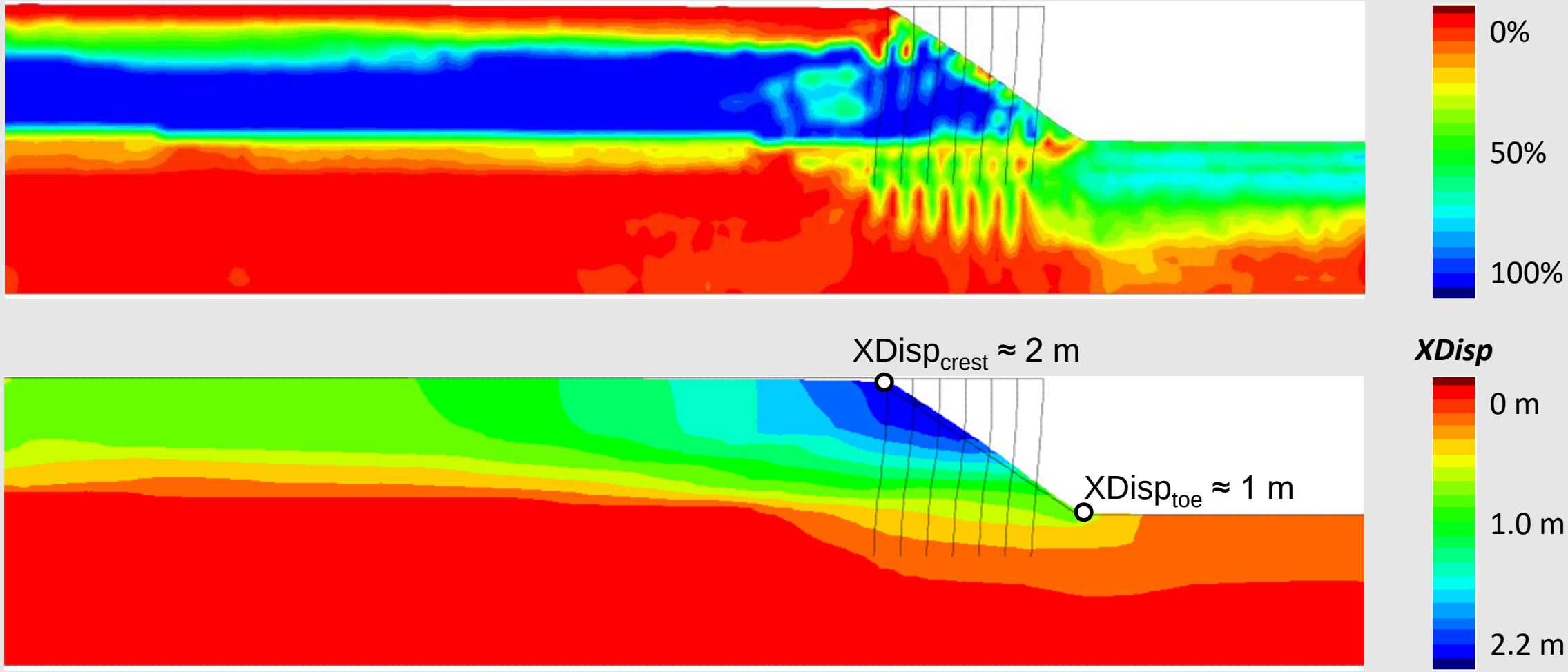
2D Nonlinear Dynamic Analyses



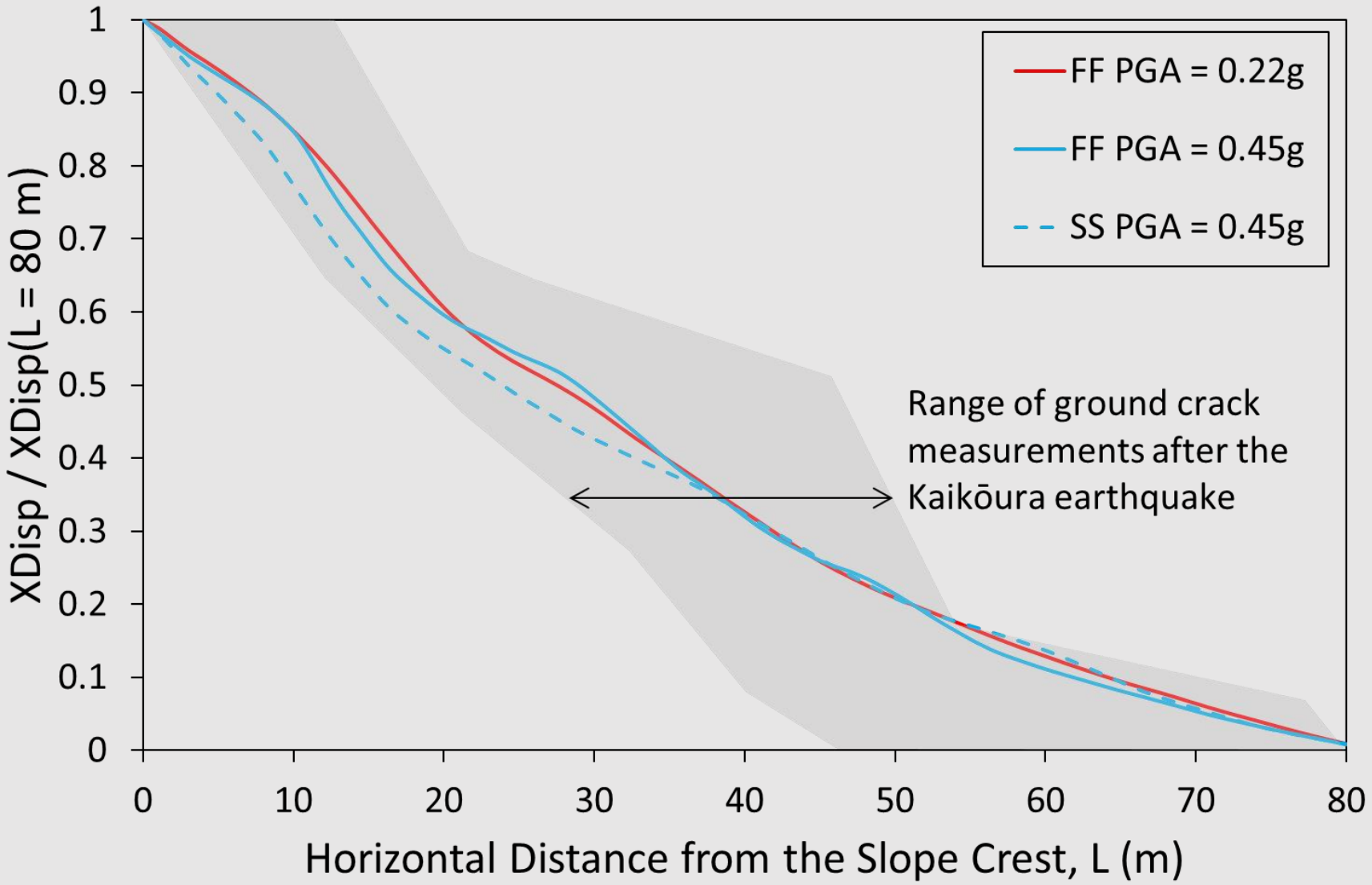


2D Nonlinear Dynamic Analyses

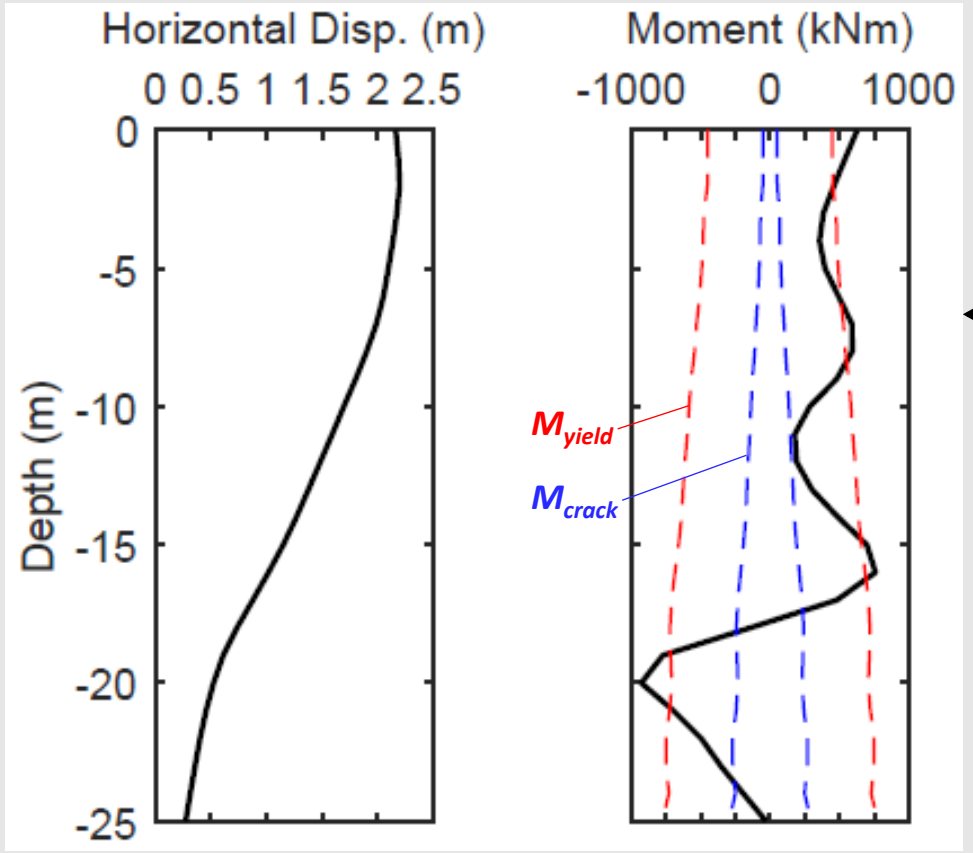
Input *PGA* = 0.45g

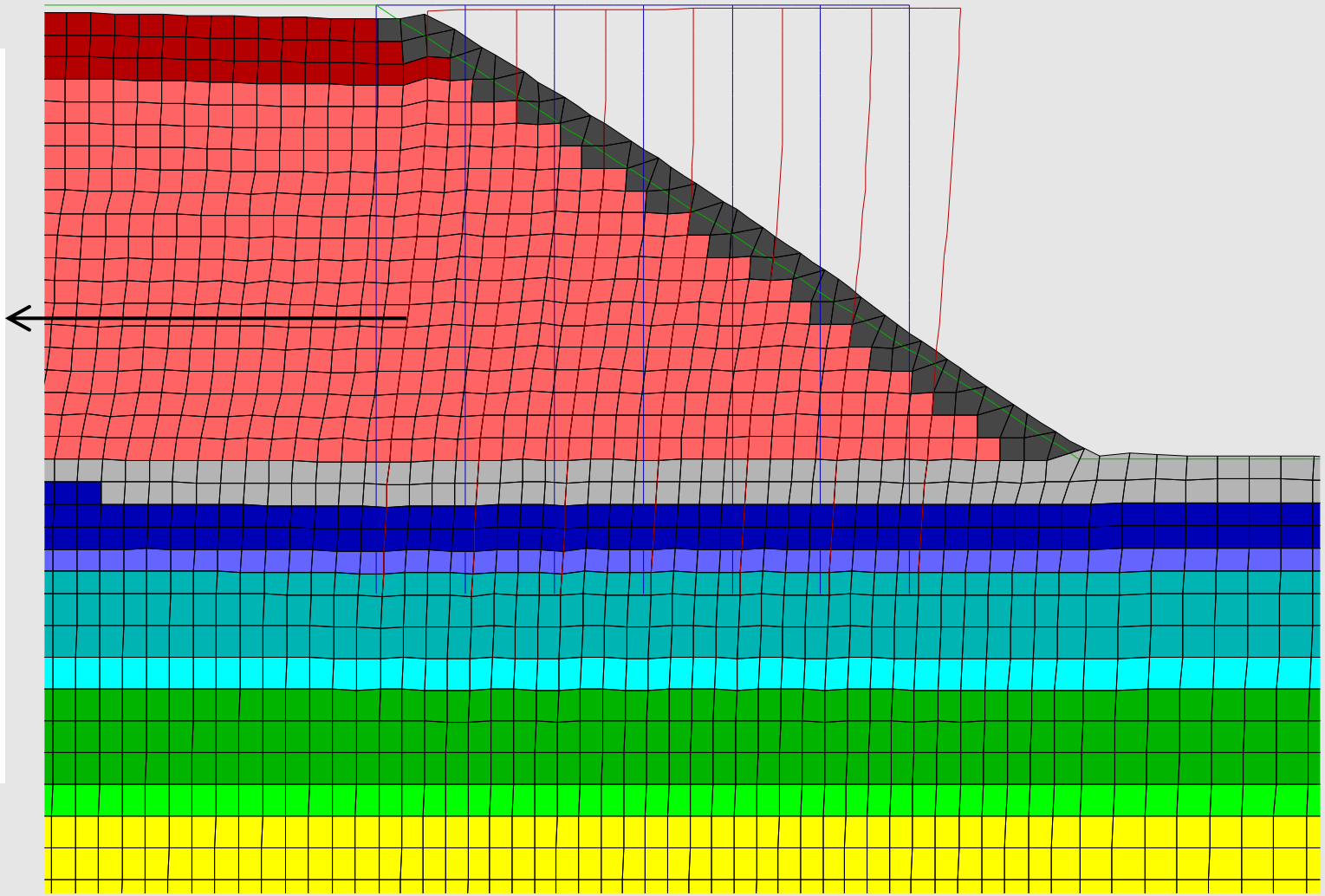


2D Nonlinear Dynamic Analyses



2D Nonlinear Dynamic Analyses





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- Port case histories improves our understanding of reclamation fill liquefaction and the seismic performance of an important wharf structures
- Ongoing work
  - Interpretation and synthesis of laboratory testing data
  - Refine 2D numerical model + sensitivity studies
- Outputs:
  - Insights in applicability of existing assessment methods for NZ-specific case histories
  - Development of simplified, advanced and laboratory assessment methods for nonstandard soils
  - Liquefaction hazard maps at and around the waterfront

References

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Thank You for Your Attention

Any Questions?

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