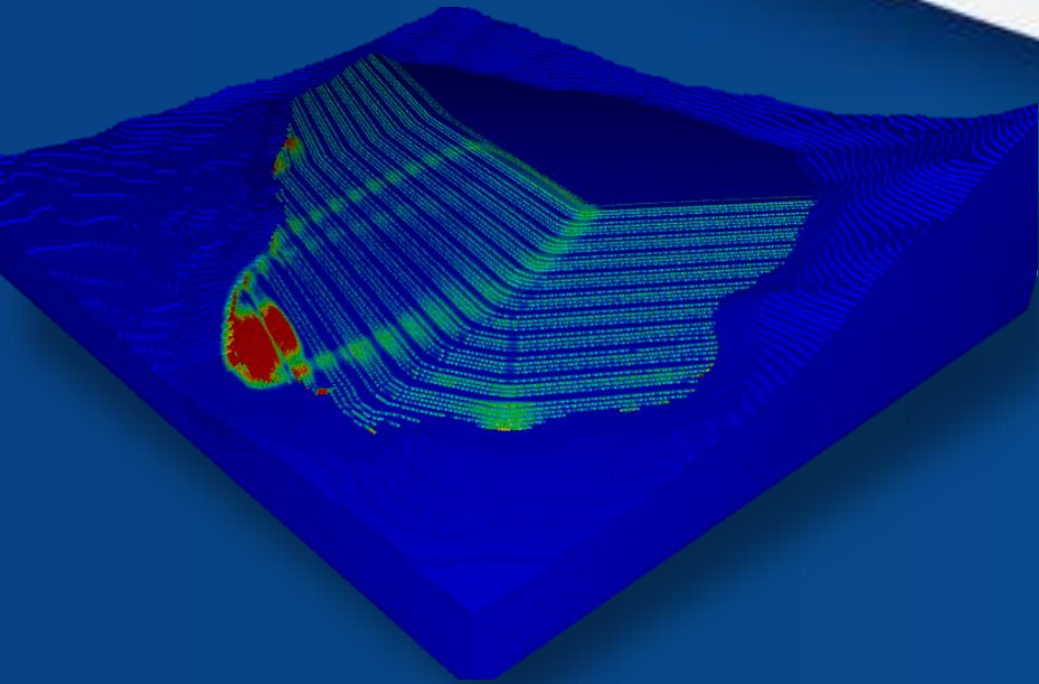




Presenter: Katy O'Brien



ASSESSING DYNAMIC STABILITY OF TAILINGS SLOPES UTILISING FLAC3D

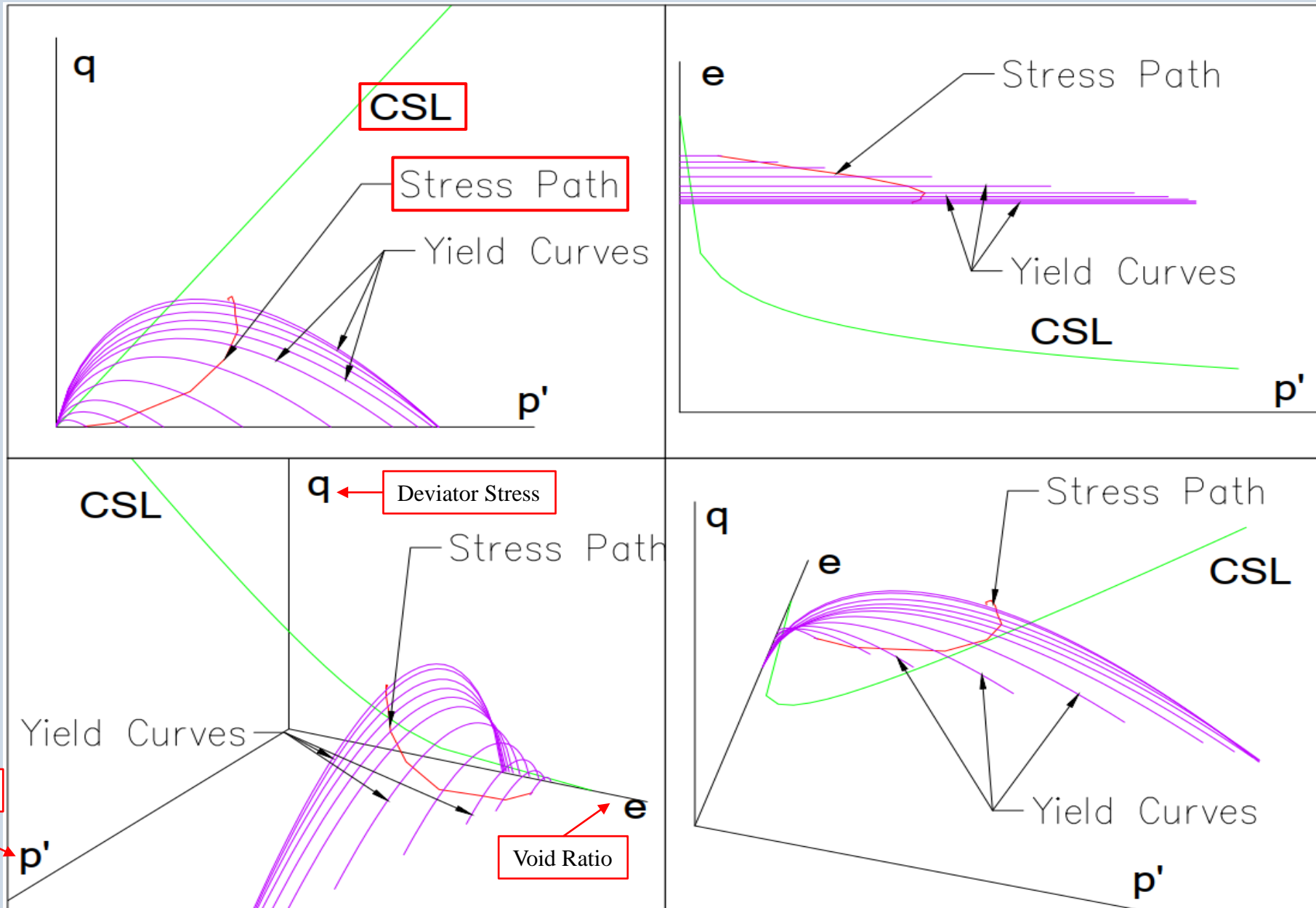
BACKGROUND AND INTRODUCTION

- In the last few years, the design of TSFs has developed and become more elaborate and demanding,
- Recent failures of TSFs have brought their stability, especially against liquefaction, under scrutiny.
- Here, I will present an analytical method to **assess potential seismic liquefaction triggers** making use of **FLAC3D** software and **critical state constitutive models**.

CONSTITUTIVE MODELS

- To assess the tailings response to triggering mechanisms, a constitutive soil model was required to replicate material behaviour as accurately as possible.
- The Critical State NorSand Constitutive Model was selected as a tool to do this.
- This Constitutive model became available in FLAC3D Version 7.
- This model is able to accurately capture the dilatant behaviour of dense soils and equally as important the contractive behaviour of loose soils.
- Non-critical state material models are not able to do this.

CONSTITUTIVE MODELS



Mean Effective Stress

CSL

Stress Path

Yield Curves

Stress Path

Yield Curves

CSL

CSL

Deviator Stress

Stress Path

Yield Curves

Void Ratio

Stress Path

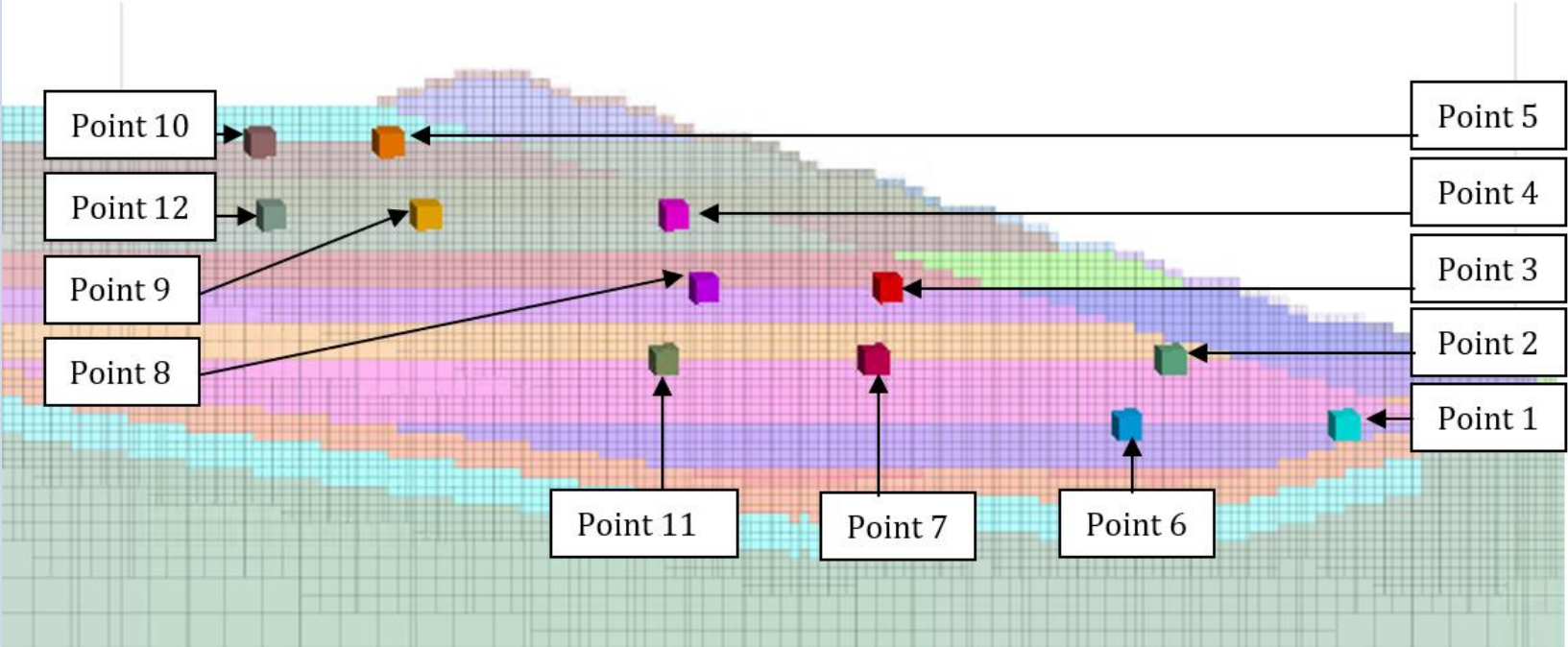
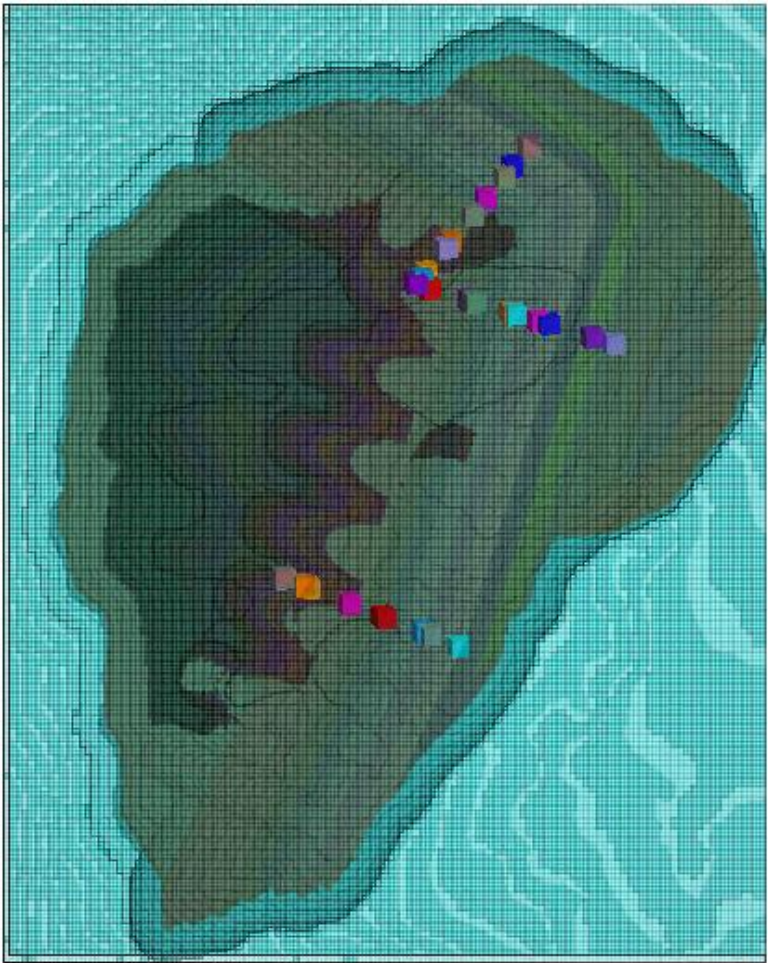
CSL

Yield Curves

CONSTITUTIVE MODELS

- There are also other constitutive models which could be used.
- We are currently researching the use of **P2PSand model** as well

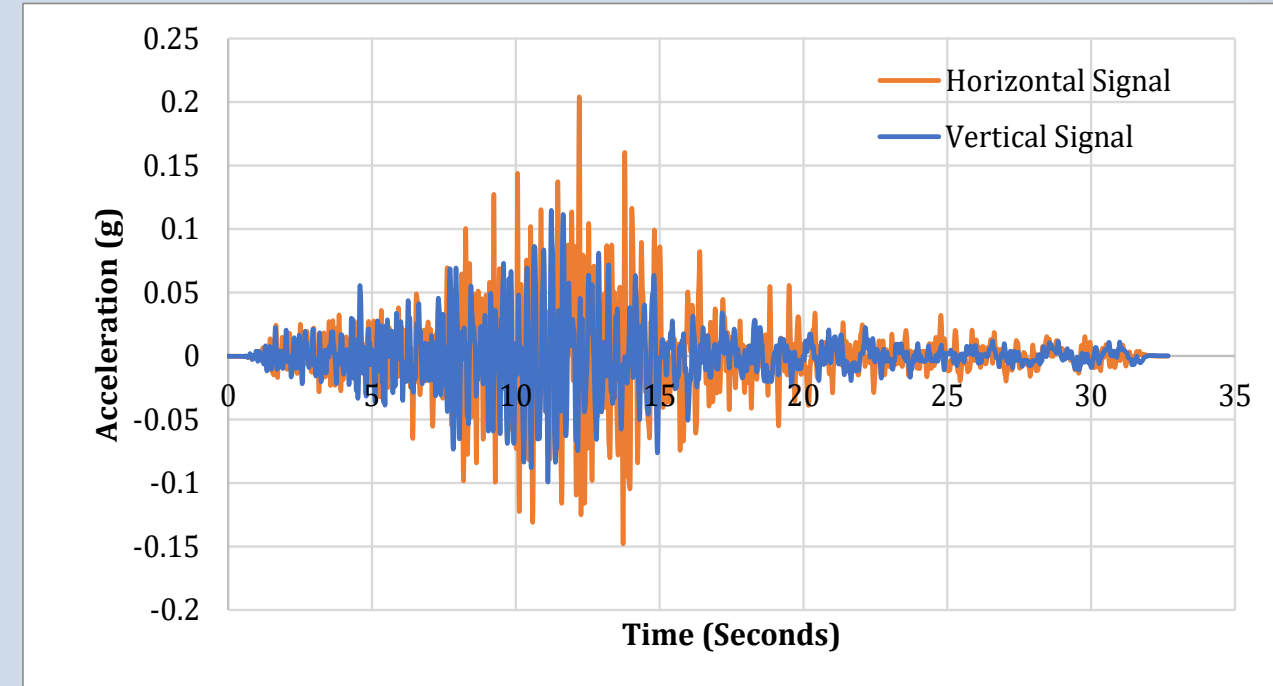
ASSESSING TAILINGS STATE



Points assessed on a typical cross section

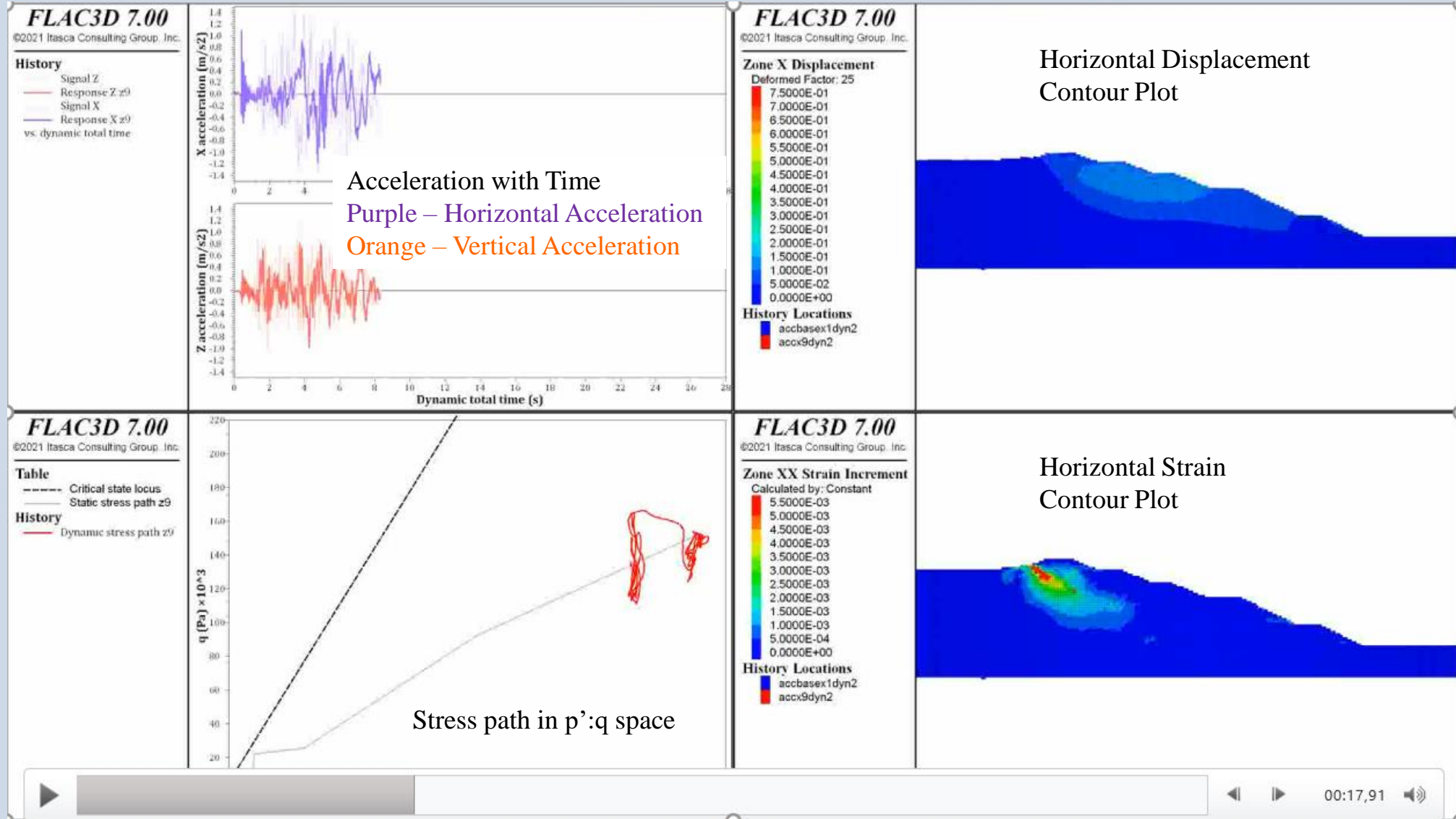
DEVELOPING A SEISMIC TIME HISTORY SIGNAL

- Historically, effects of seismic loading have been considered by **applying the peak ground acceleration or a fraction thereof as a constant static load.**
- This historic approach is **limited/flawed** as real seismic events are of relatively short duration and impose dynamic/cyclic load.
- Our approach involves a **dynamic load** being developed using inputs from a site specific PSHA and applied to the base of the model



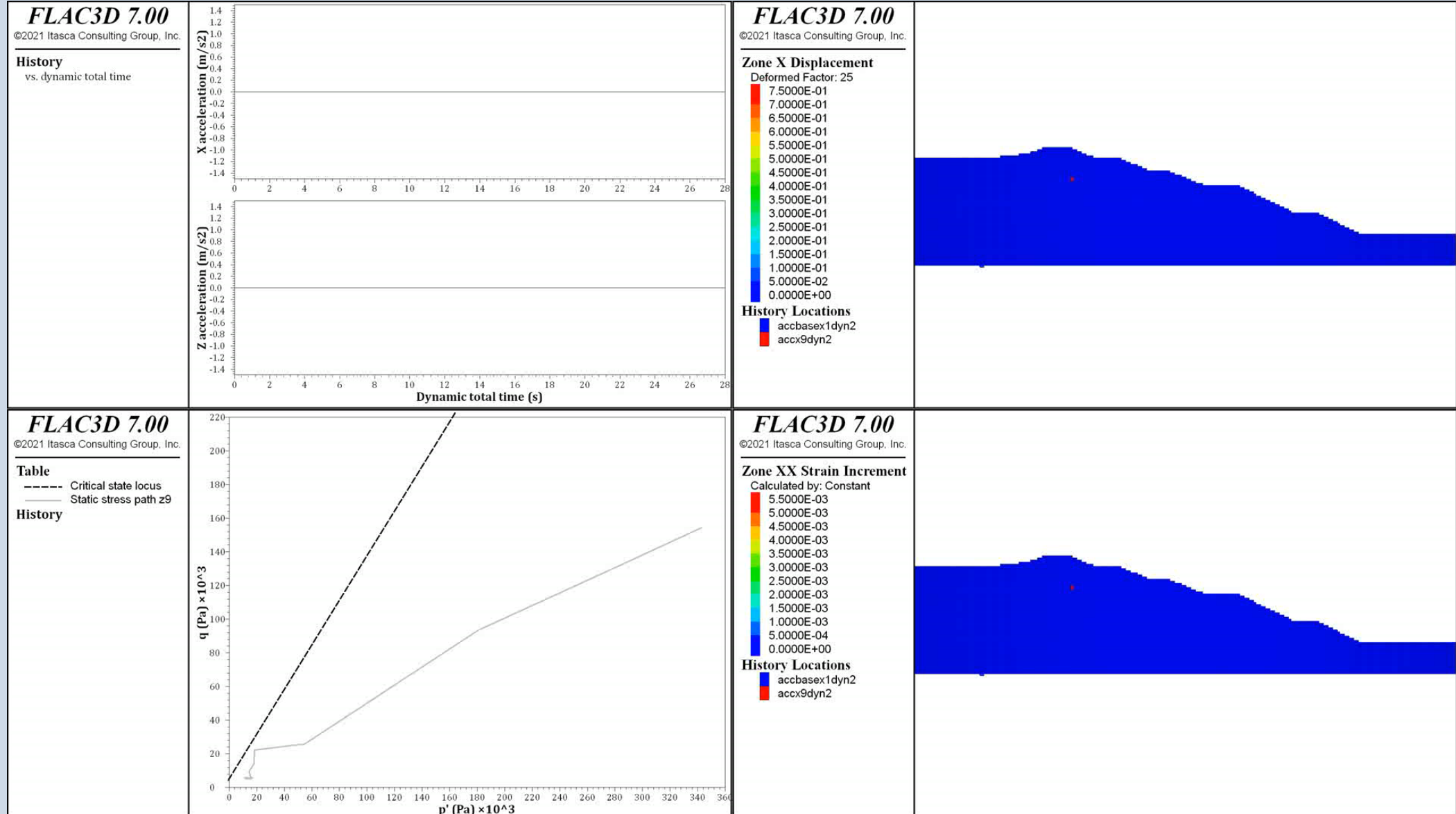
STABILITY ASSESSMENT

Trigger Mechanism – Seismic Event

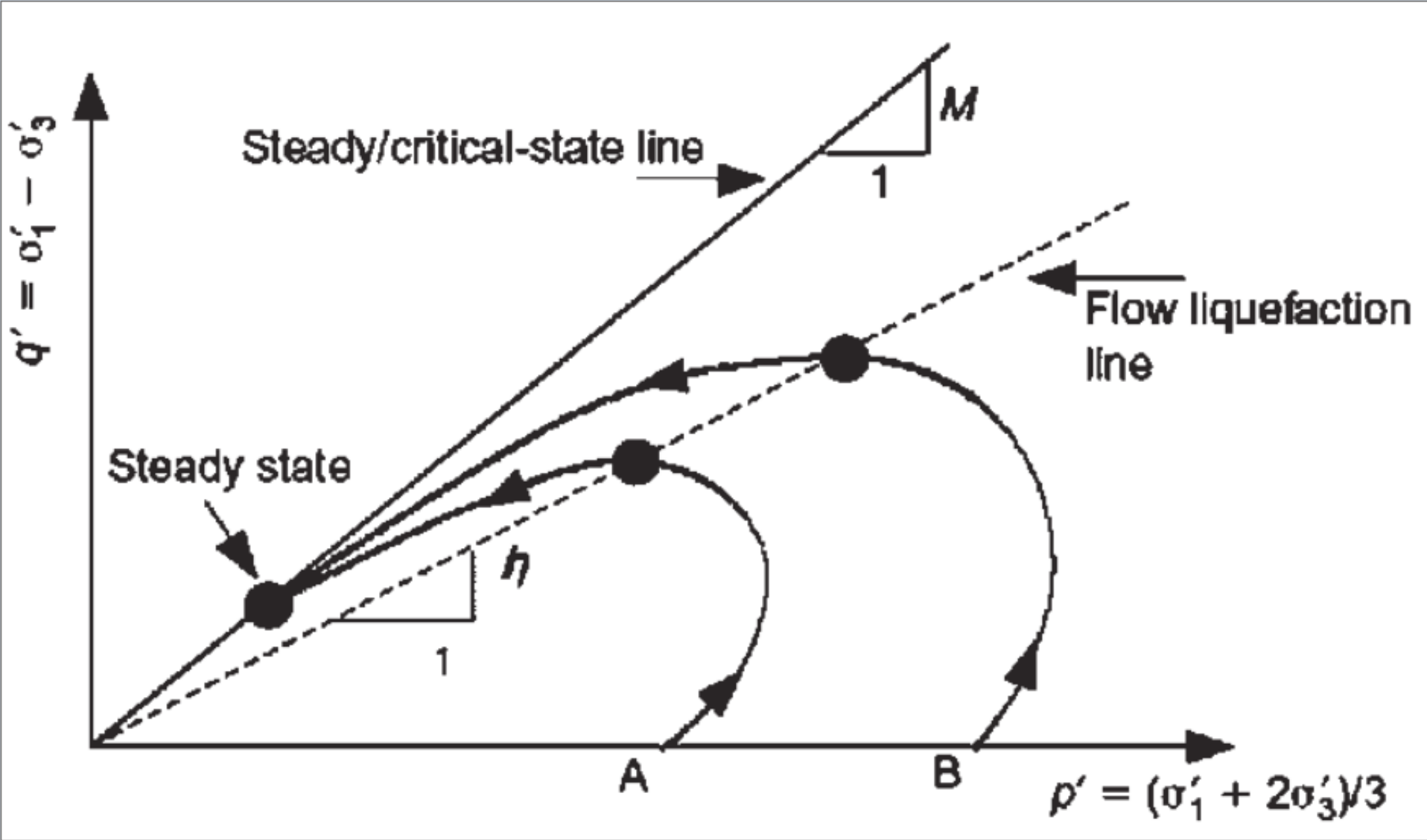


STABILITY ASSESSMENT

Trigger Mechanism – Seismic Event



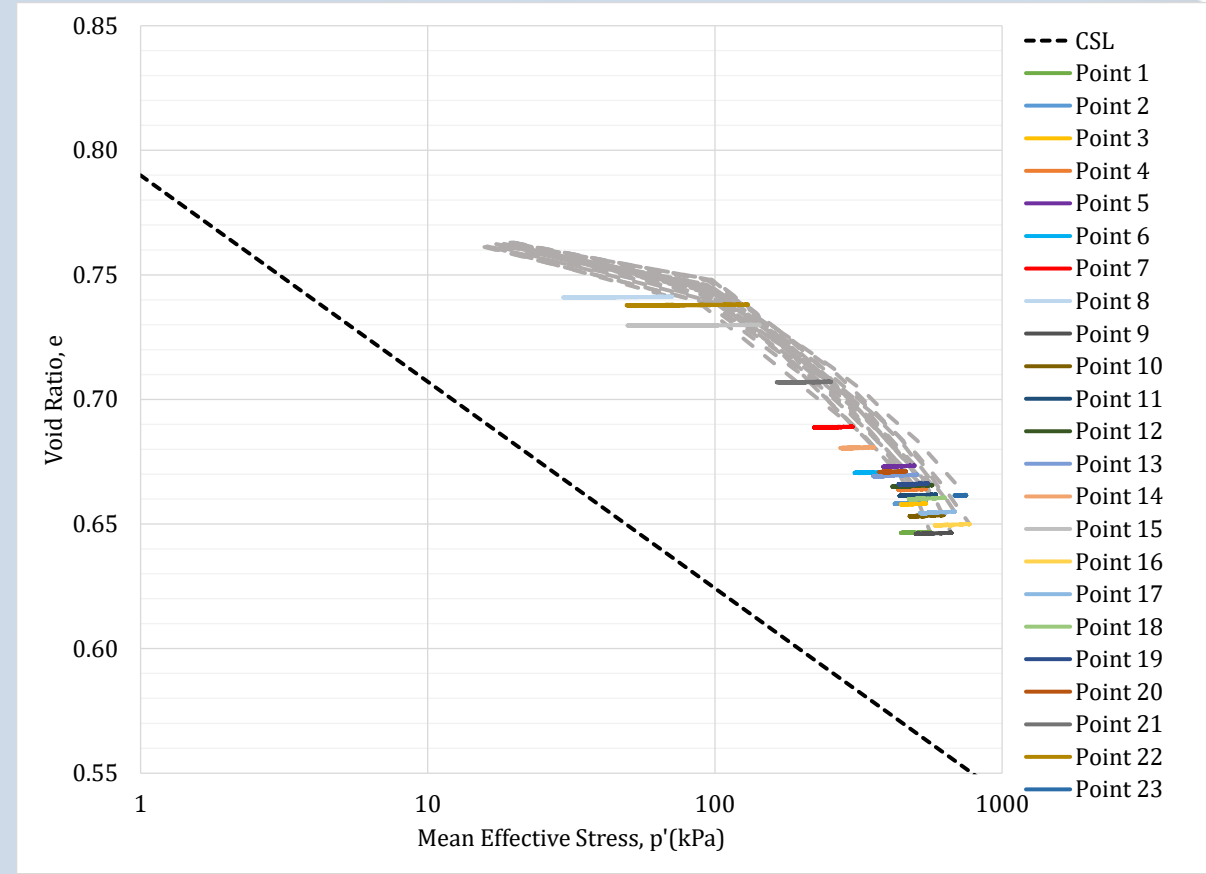
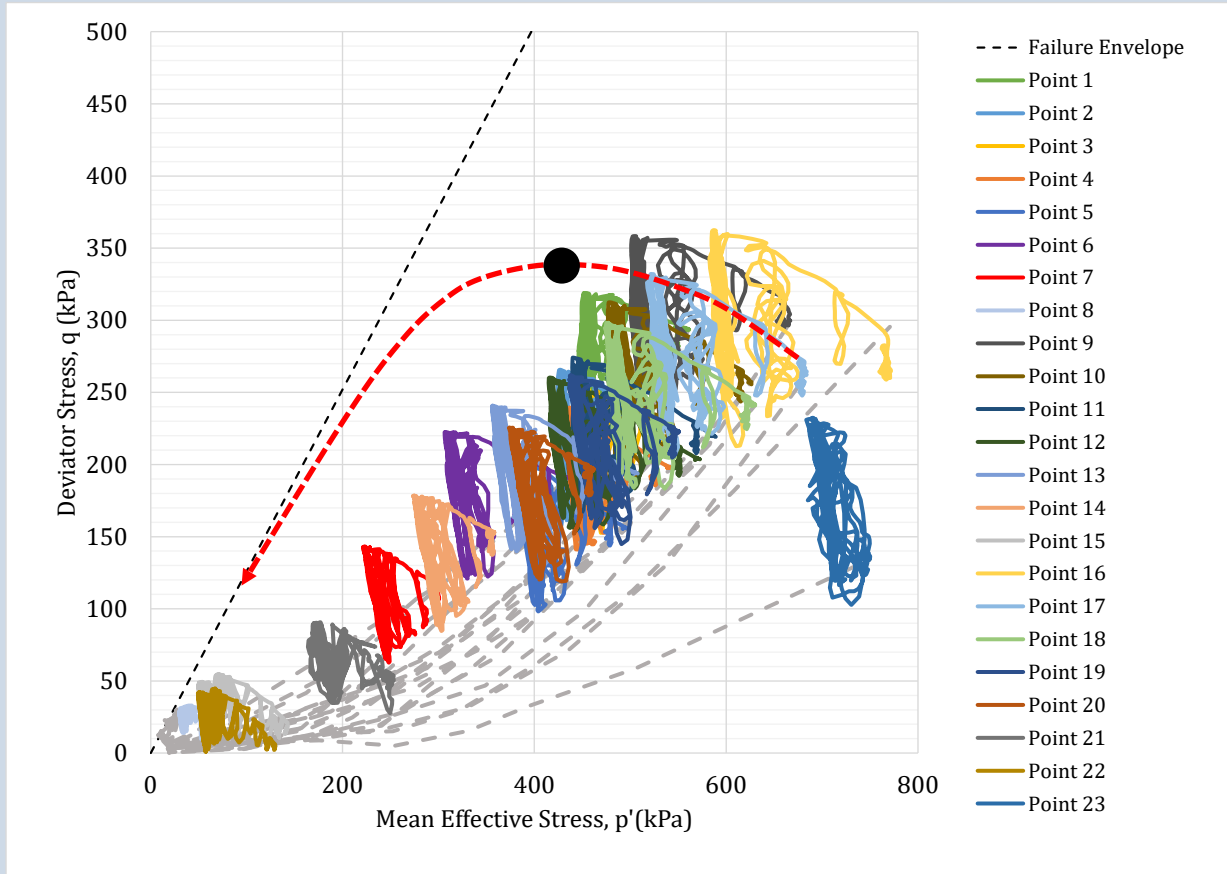
A FEW QUICK NOTES ON LIQUEFACTION



STABILITY ASSESSMENT - THE ADVANCED APPROACH

Trigger Mechanism – Seismic Event

Case Study 1

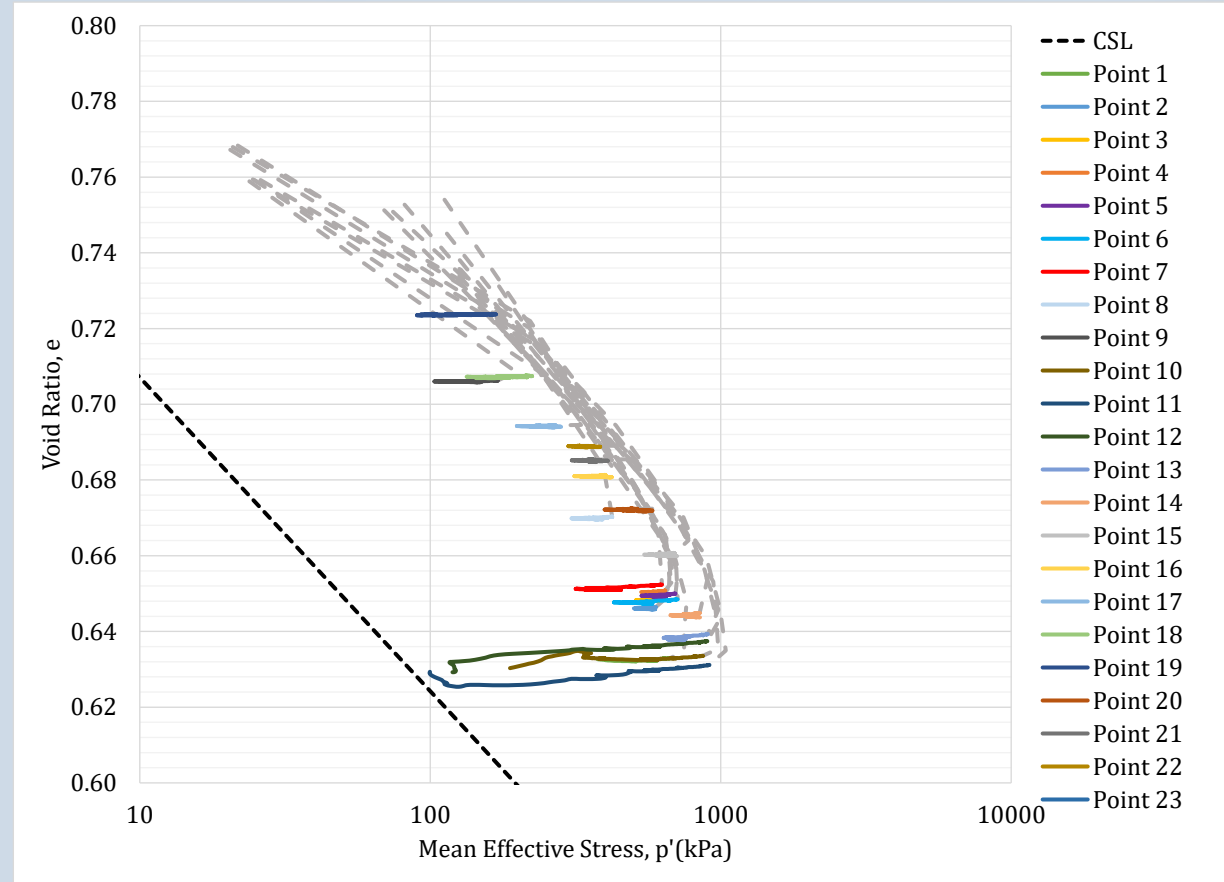
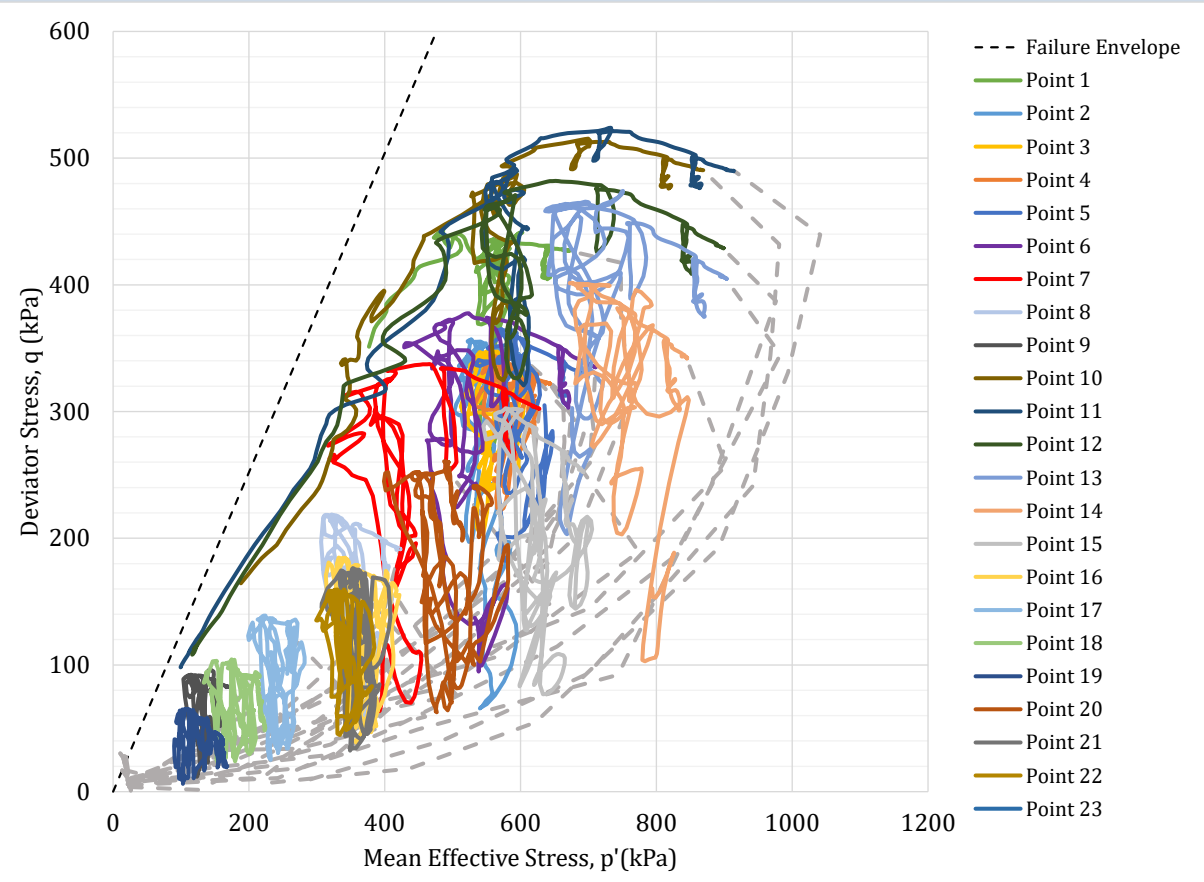


No Liquefaction
CS has not been reached

STABILITY ASSESSMENT - THE ADVANCED APPROACH

Trigger Mechanism – Seismic Event

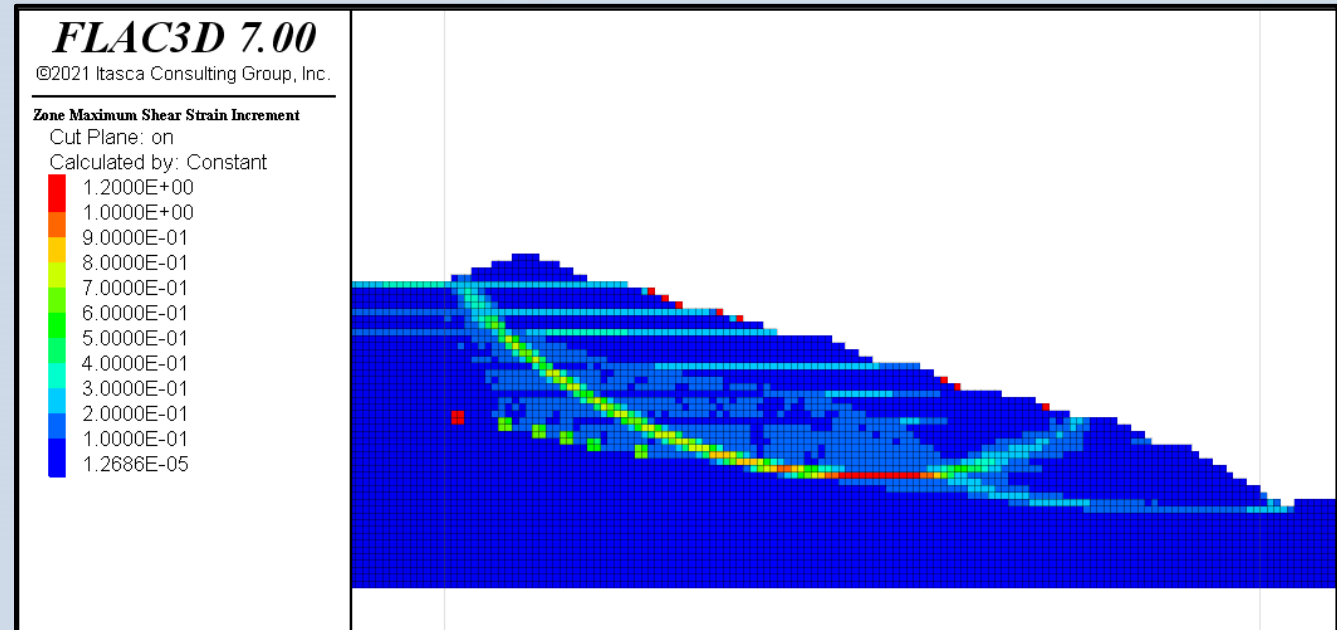
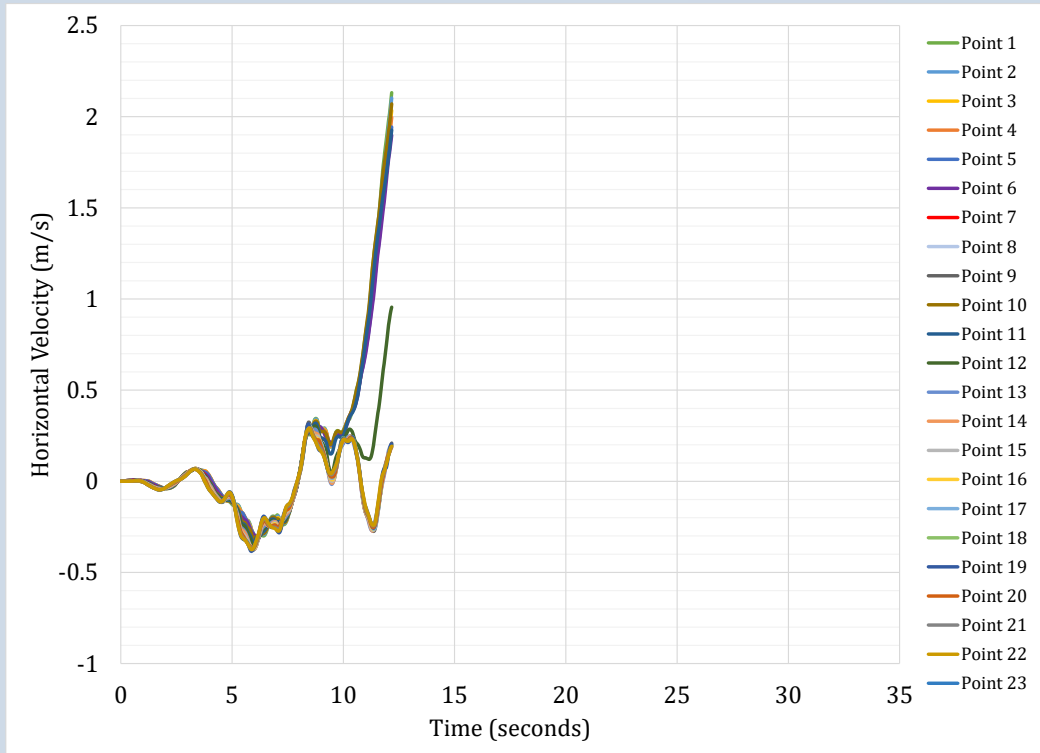
Case Study 2



STABILITY ASSESSMENT - THE ADVANCED APPROACH

Trigger Mechanism – Seismic Event

Case Study 2

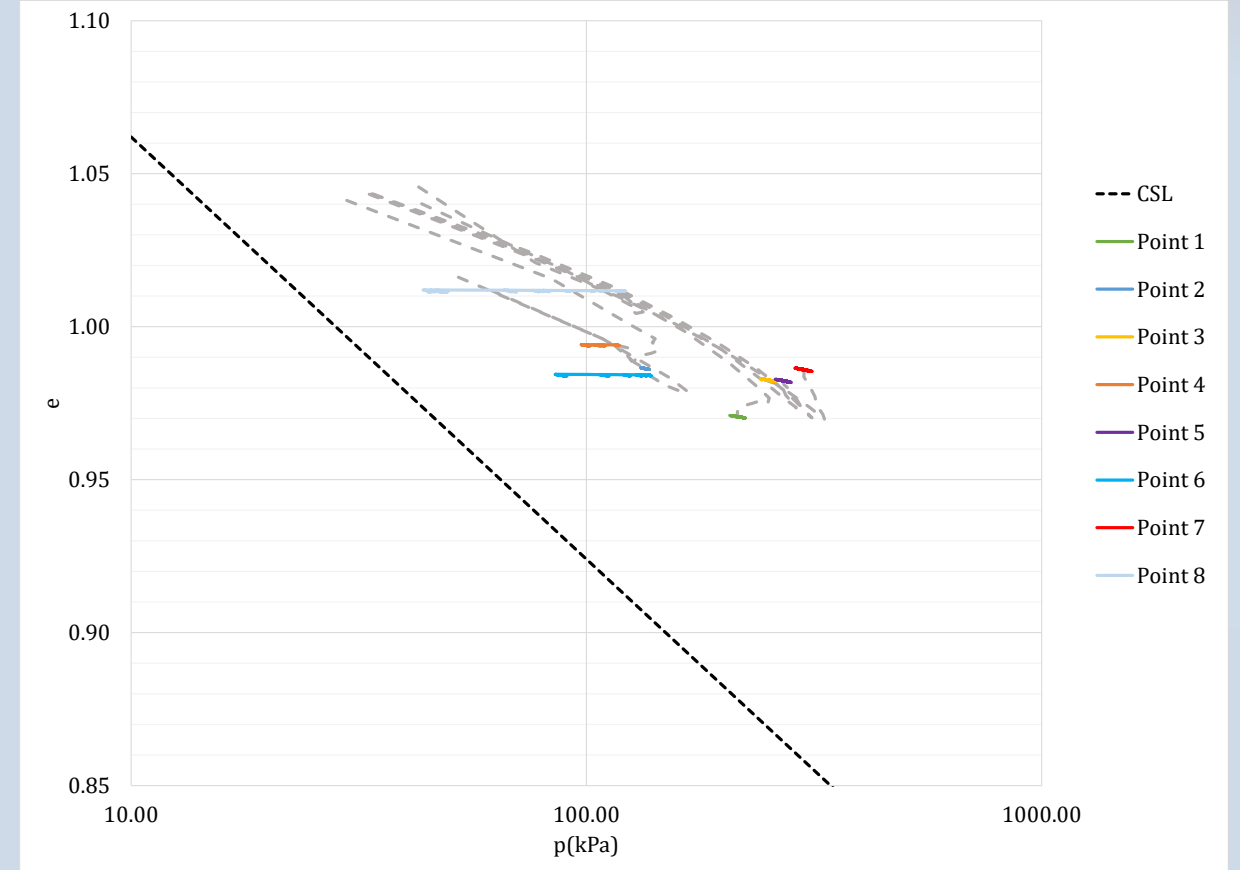
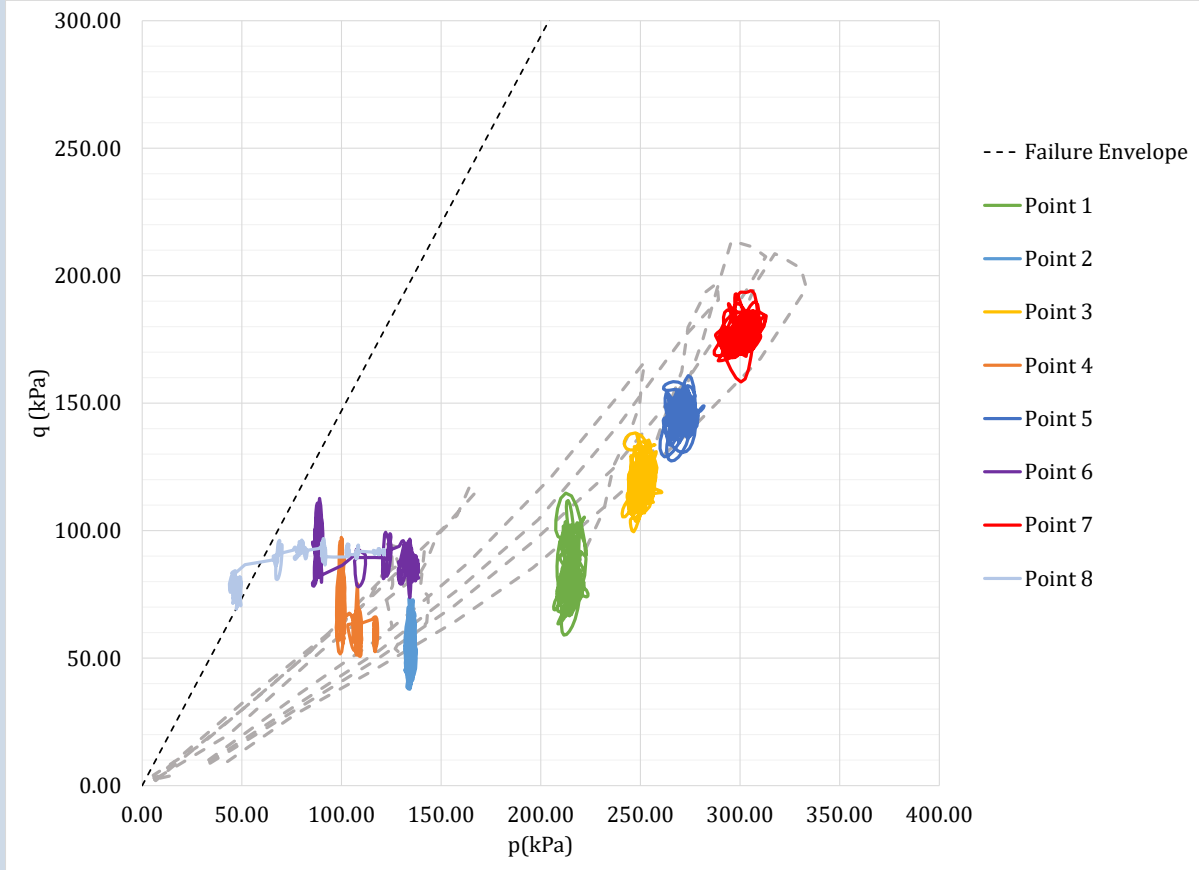


Liquefaction and CS have been reached in some of the points
Mobilisation of the slope has occurred

STABILITY ASSESSMENT - THE ADVANCED APPROACH

Trigger Mechanism – Seismic Event

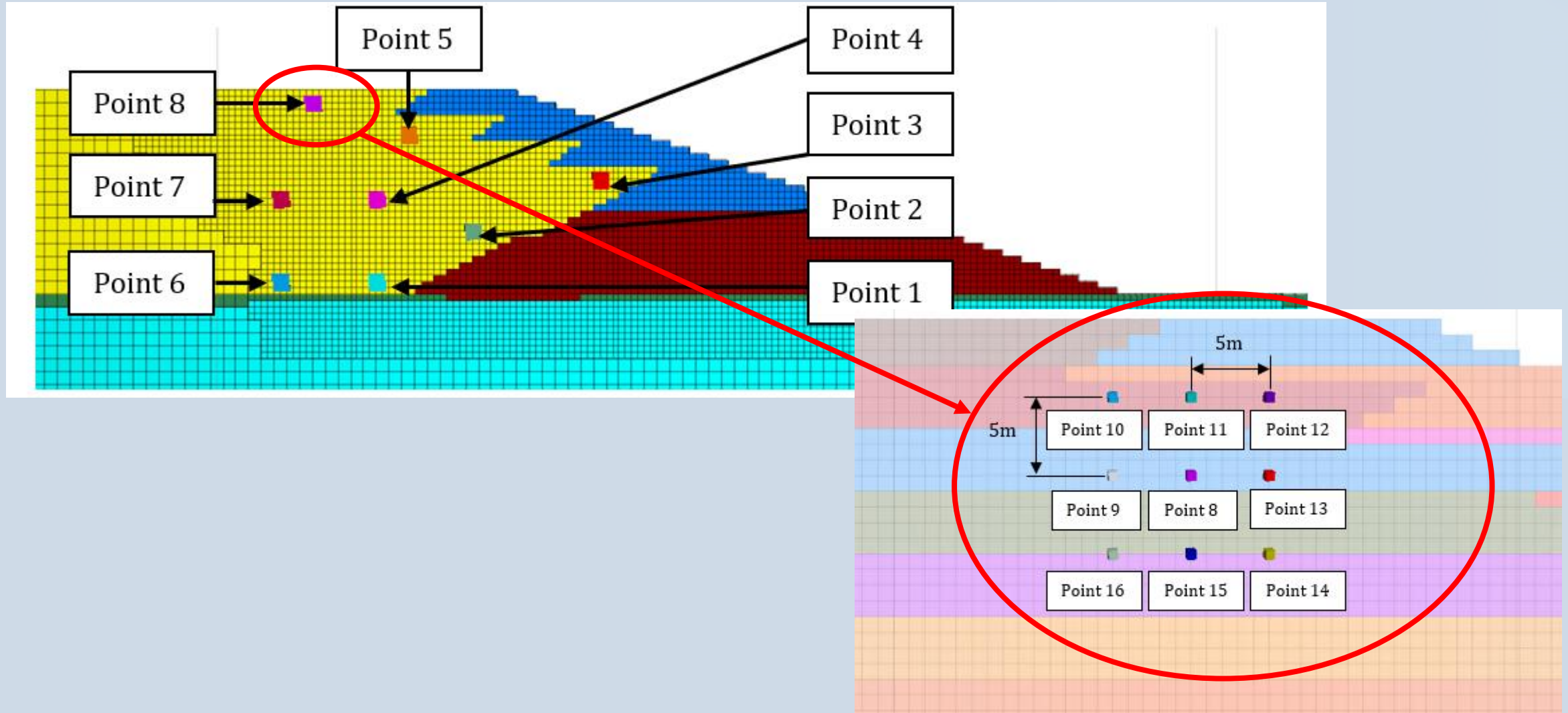
Case Study 3



STABILITY ASSESSMENT - THE ADVANCED APPROACH

Trigger Mechanism – Seismic Event

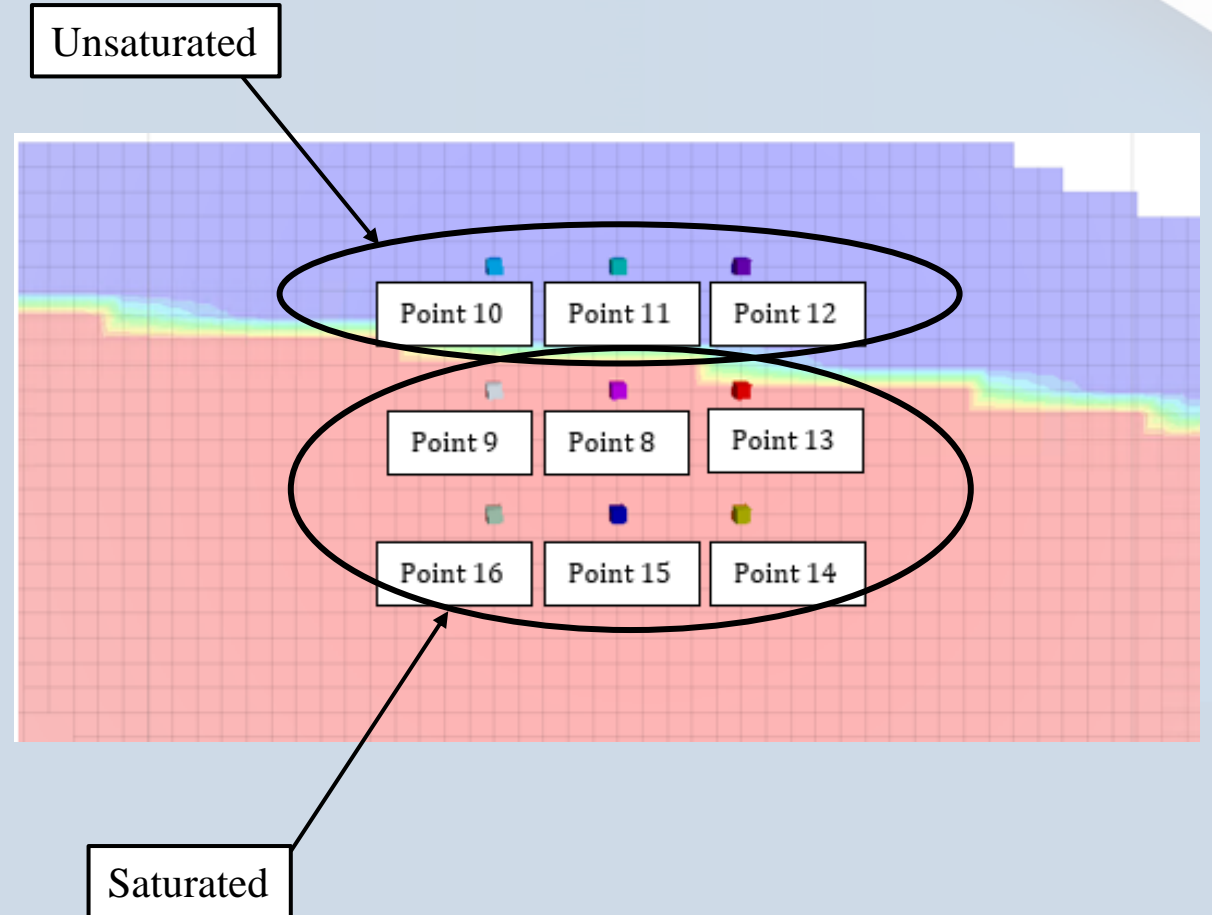
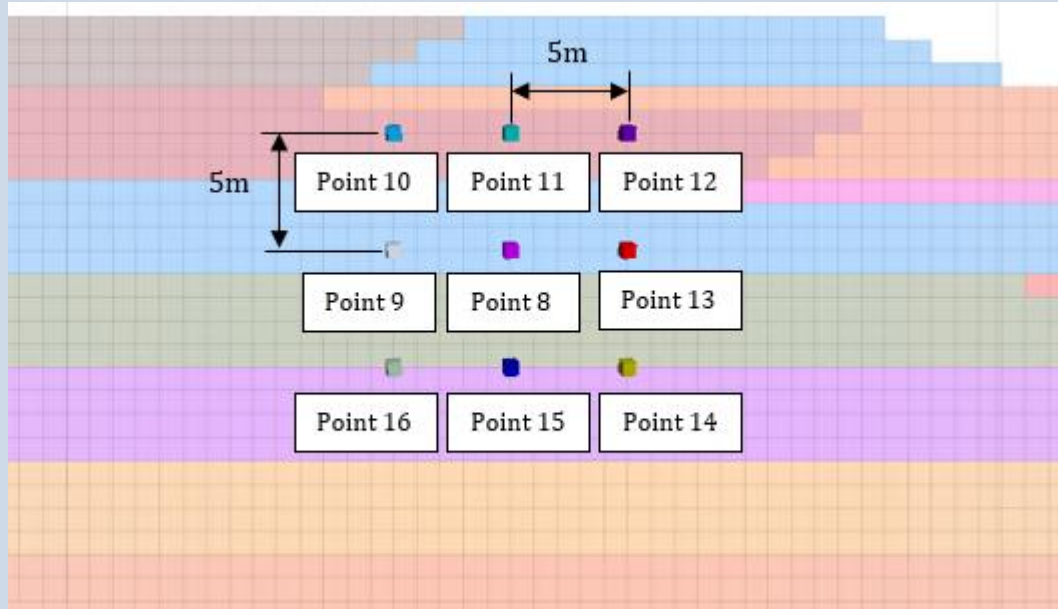
Case Study 3



STABILITY ASSESSMENT - THE ADVANCED APPROACH

Trigger Mechanism – Seismic Event

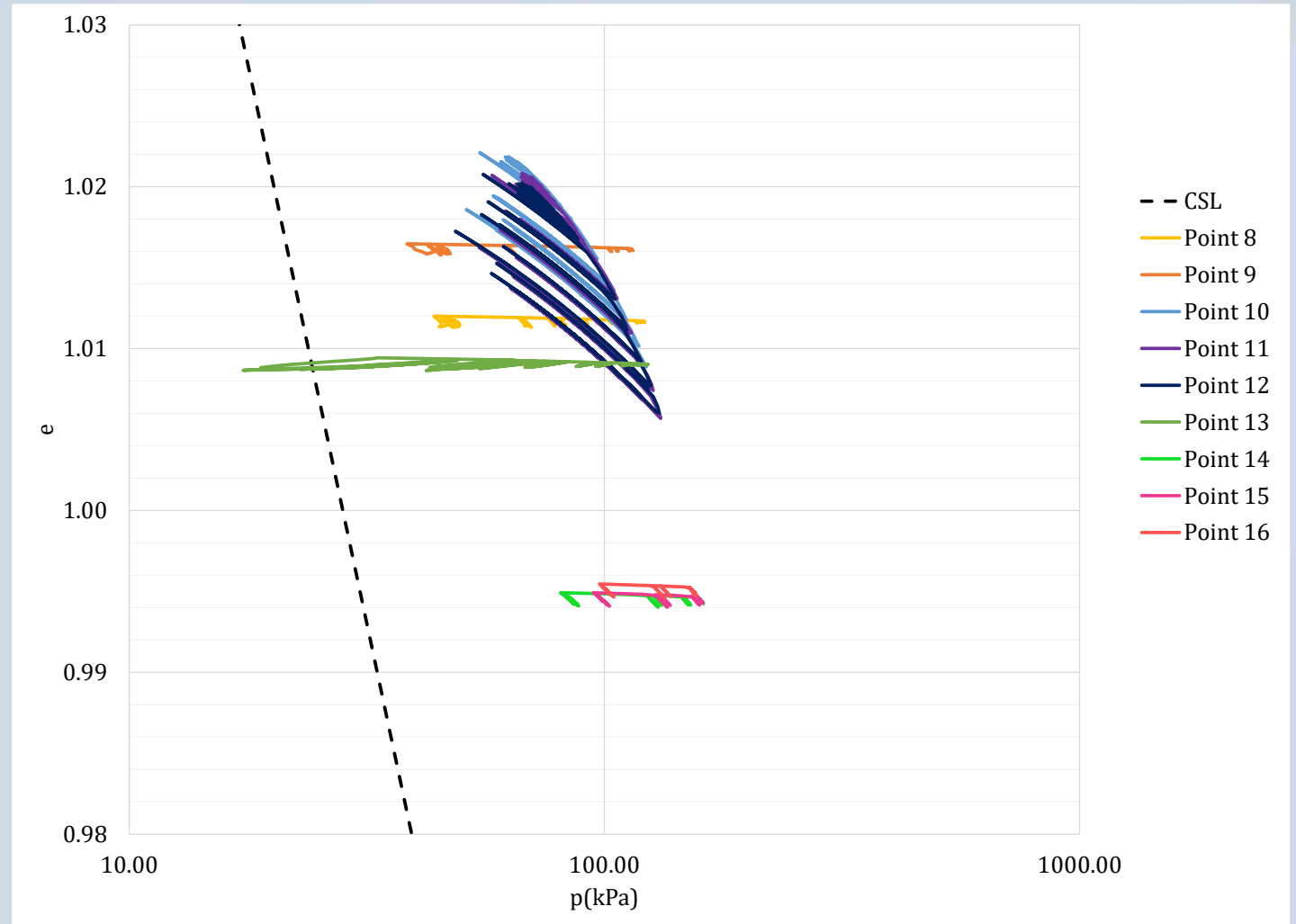
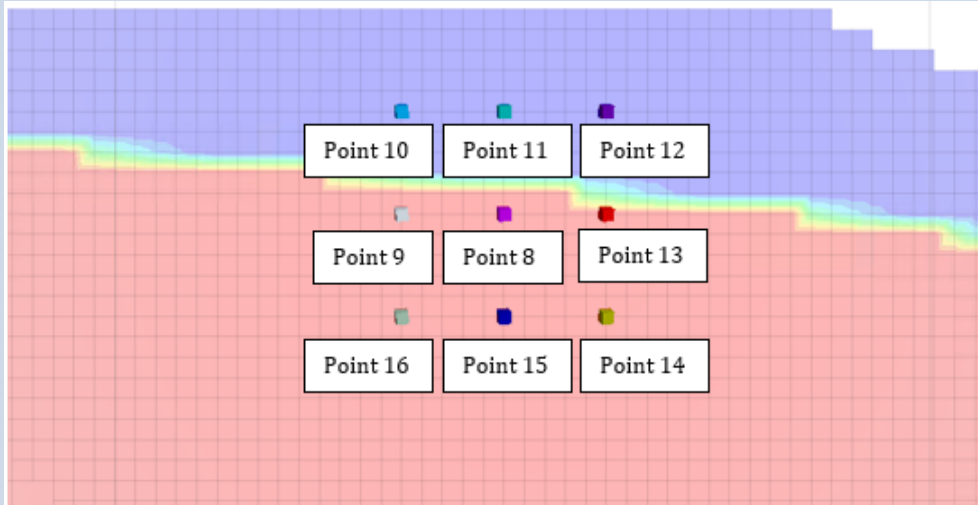
Case Study 3



STABILITY ASSESSMENT - THE ADVANCED APPROACH

Trigger Mechanism – Seismic Event

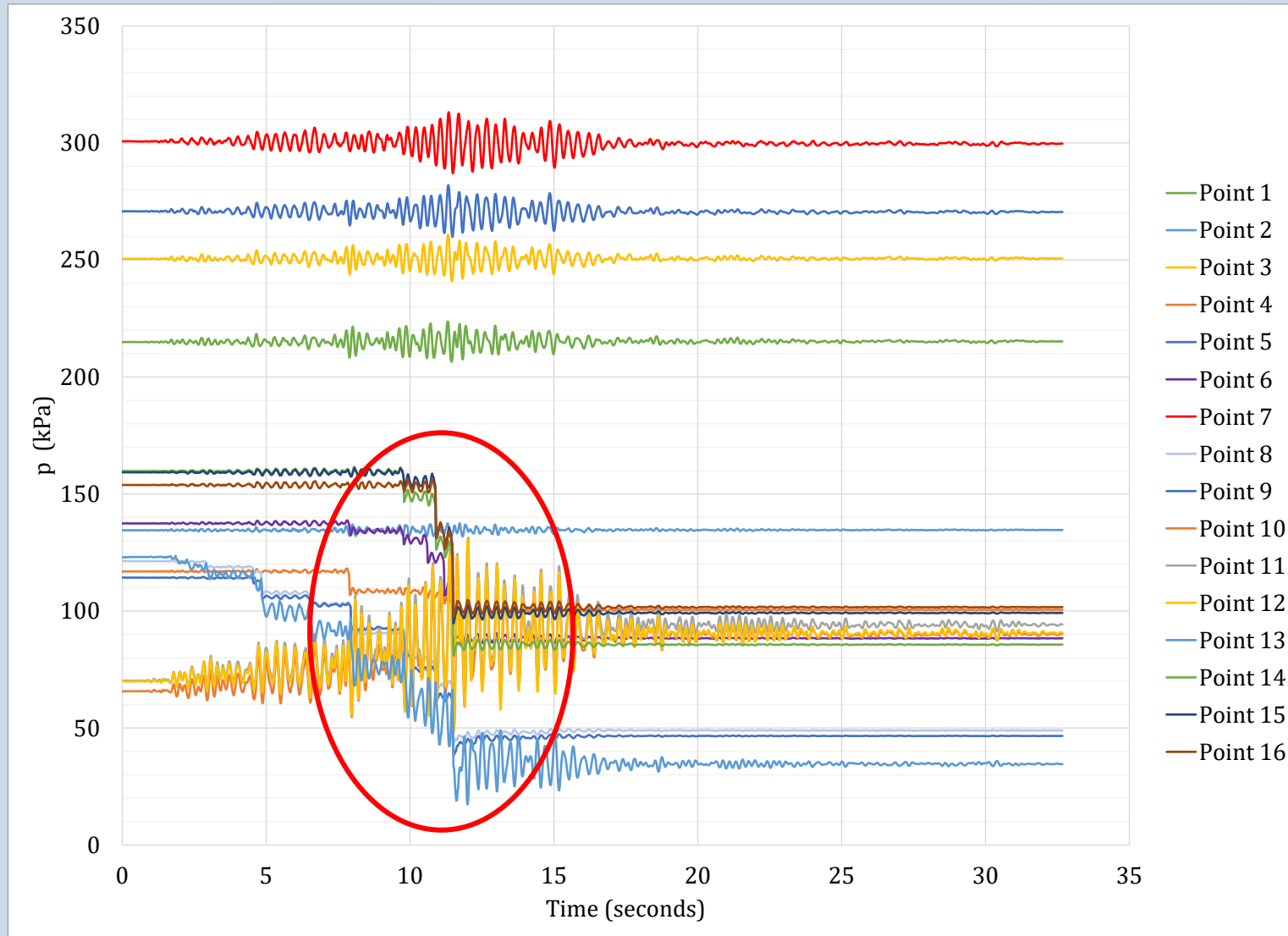
Case Study 3



STABILITY ASSESSMENT - THE ADVANCED APPROACH

Trigger Mechanism – Seismic Event

Case Study 3









































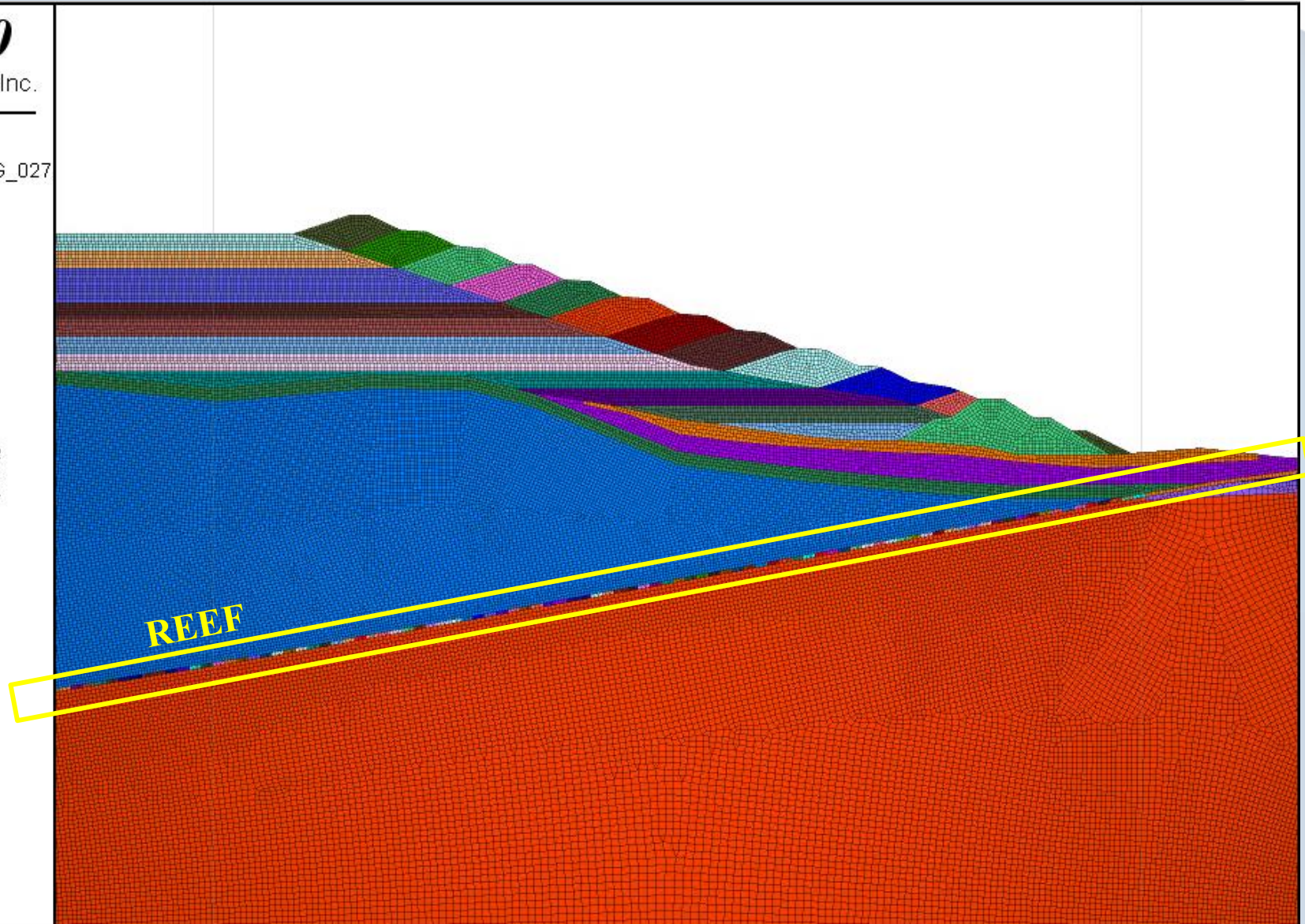
SOME CURRENT WORK...

FLAC3D 7.00

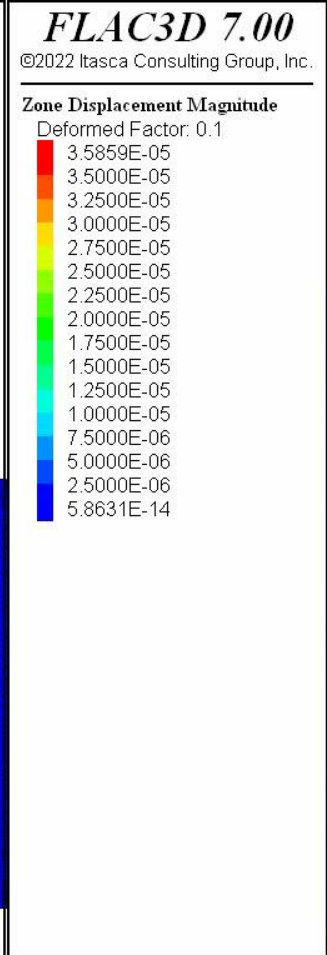
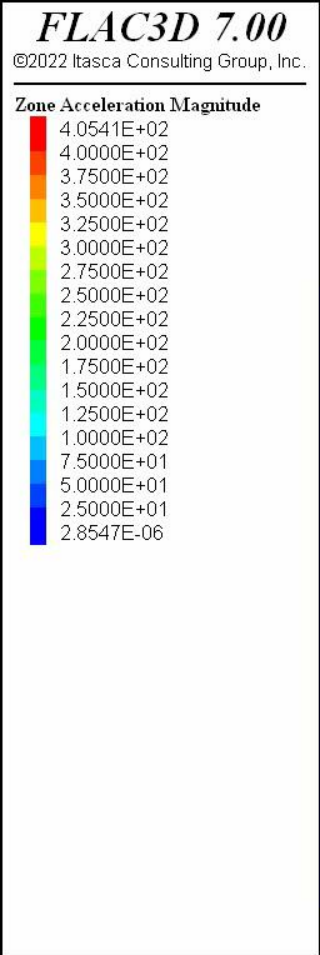
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Zone Group

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SOME CURRENT WORK...



CONCLUSIONS

- We aim to advance beyond the assessment of TSF stability using simplified analyses and conservative assumptions to provide our Clients (and society) with realistic solutions,
- The seismic triggering assessment presented here is an example of the type of rigorous approach which is necessary to accomplish this,
- Although this approach is undergoing continual adaptation and improvement, we are at a point where results are meaningful and provide insight into the behaviour of tailings facilities.

THANK YOU!