NON-LINEAR STRANINING OF FOUNDATION SOILS IN THE PROGRESSIVE FAILURE OF THE MOUNT POLLEY TSF EMBANKMENT

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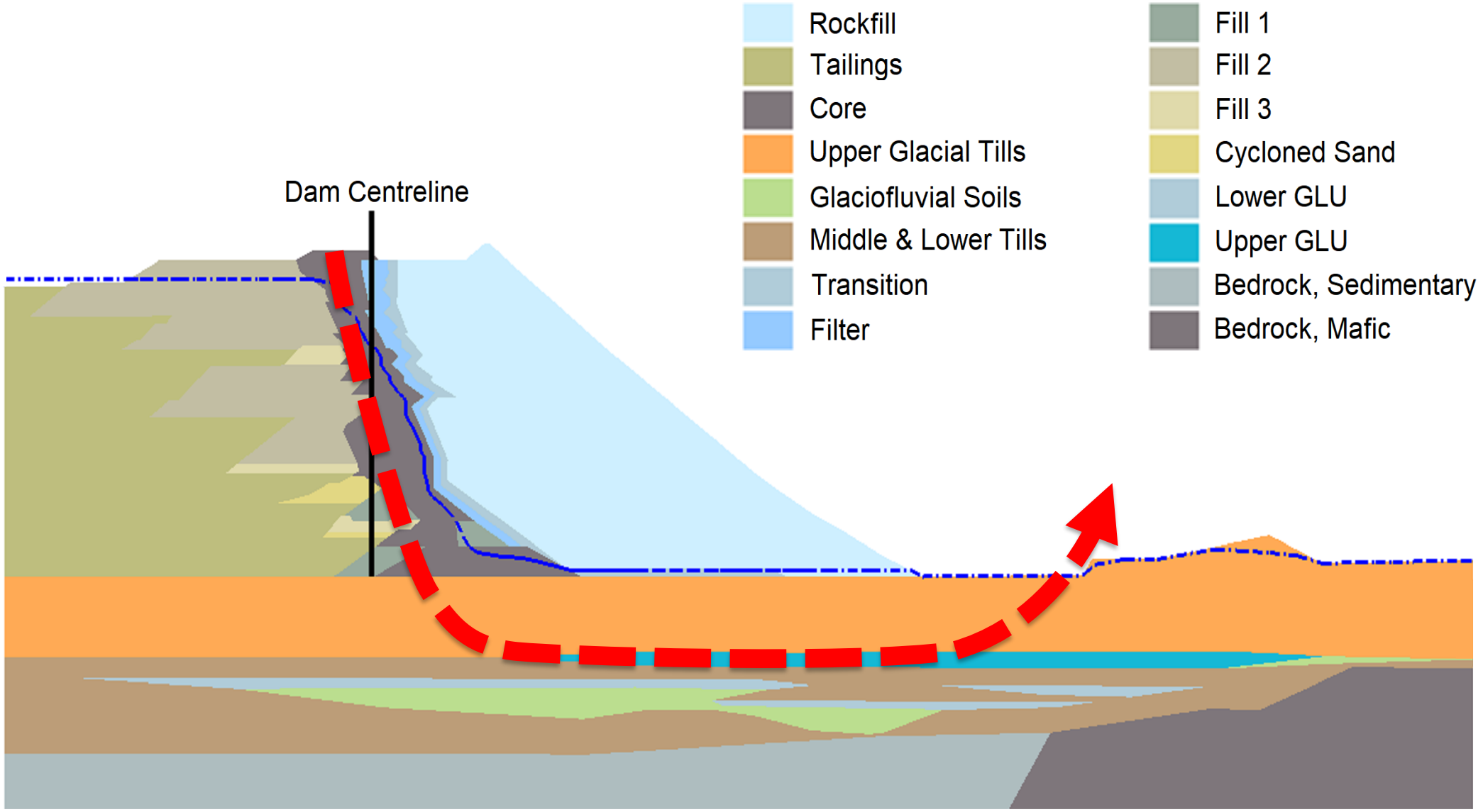
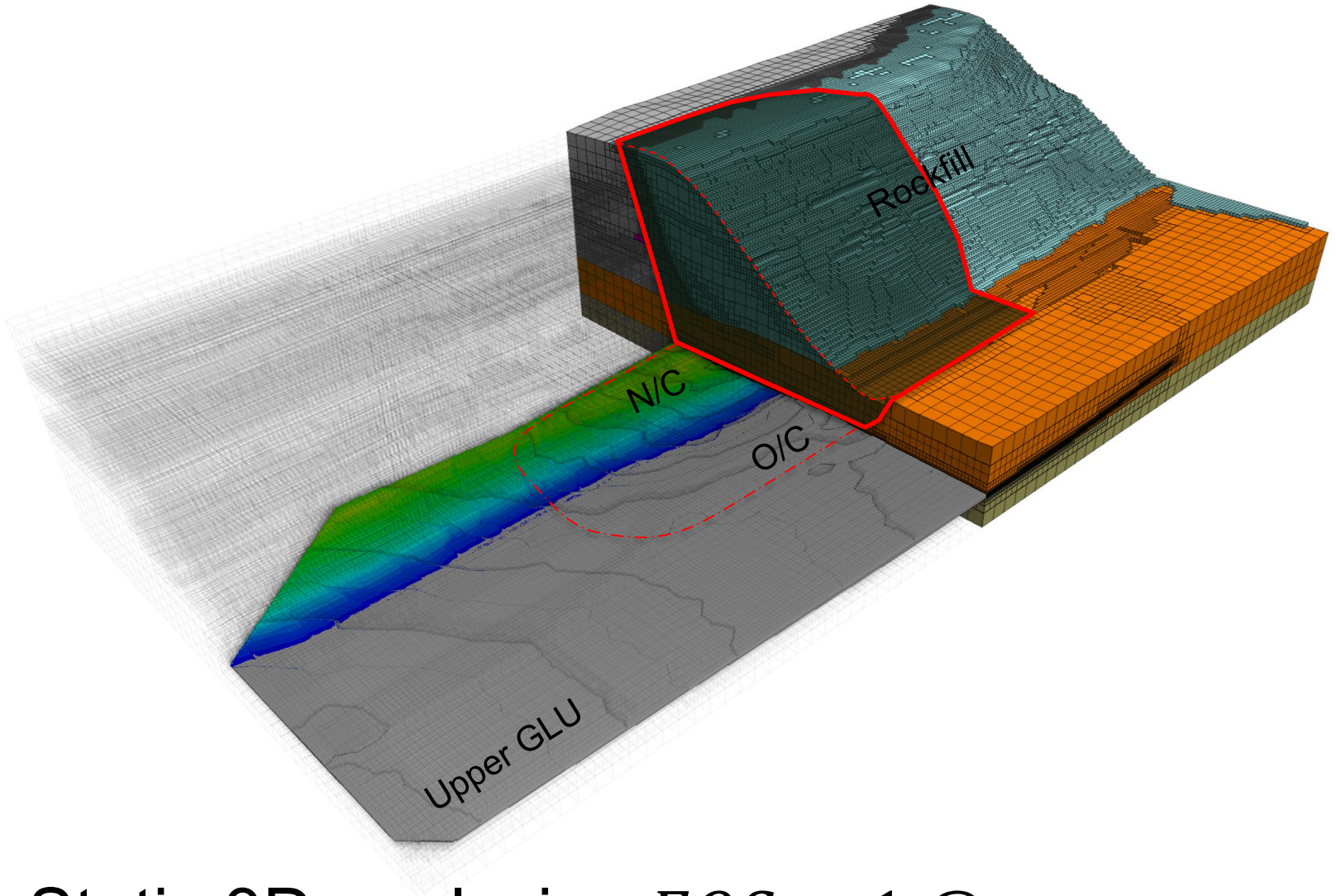
Mine
Bootjack Lake
Polley
Lake
Tailings Pond
Hazeltine Creek

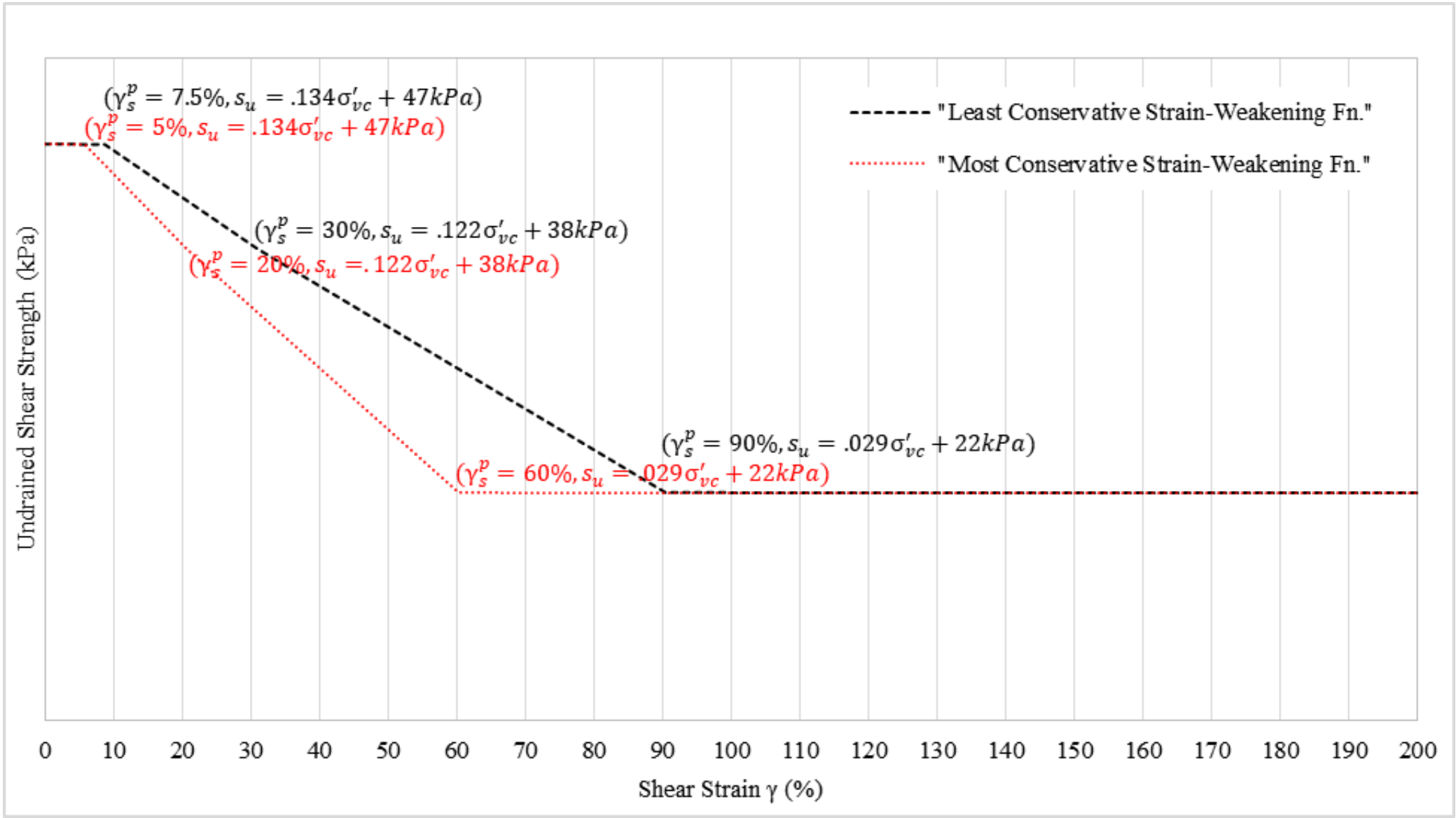
PRE-FAILURE PROFILE





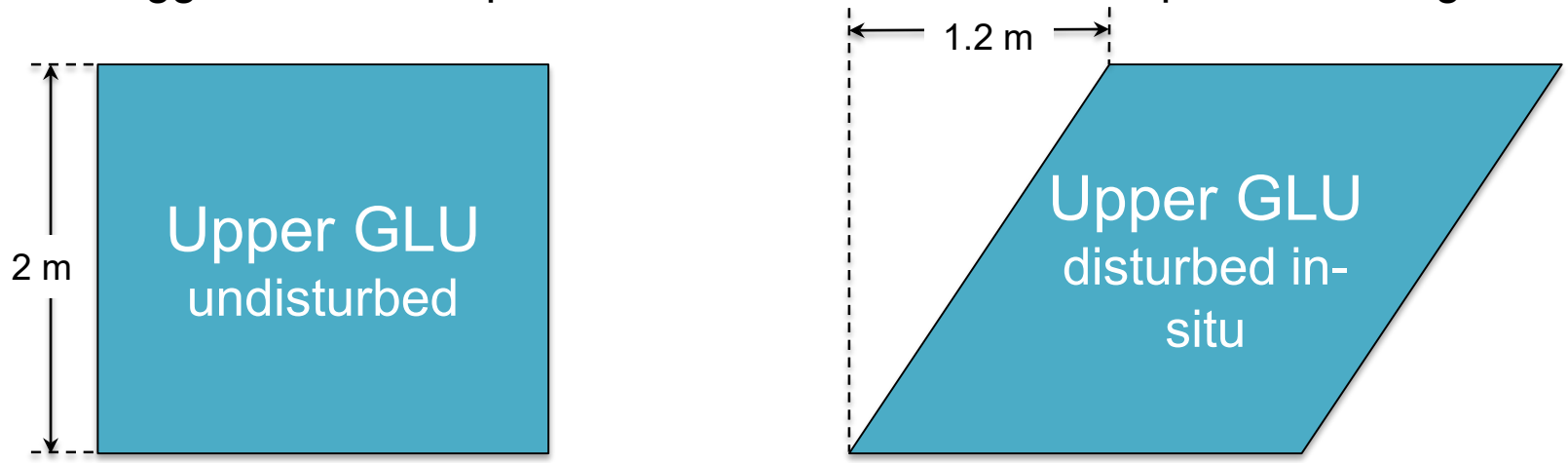
Static 3D analysis: $FOS = 1$ @ $s_{u,residual}$

DSS-derived strain-weakening curves:

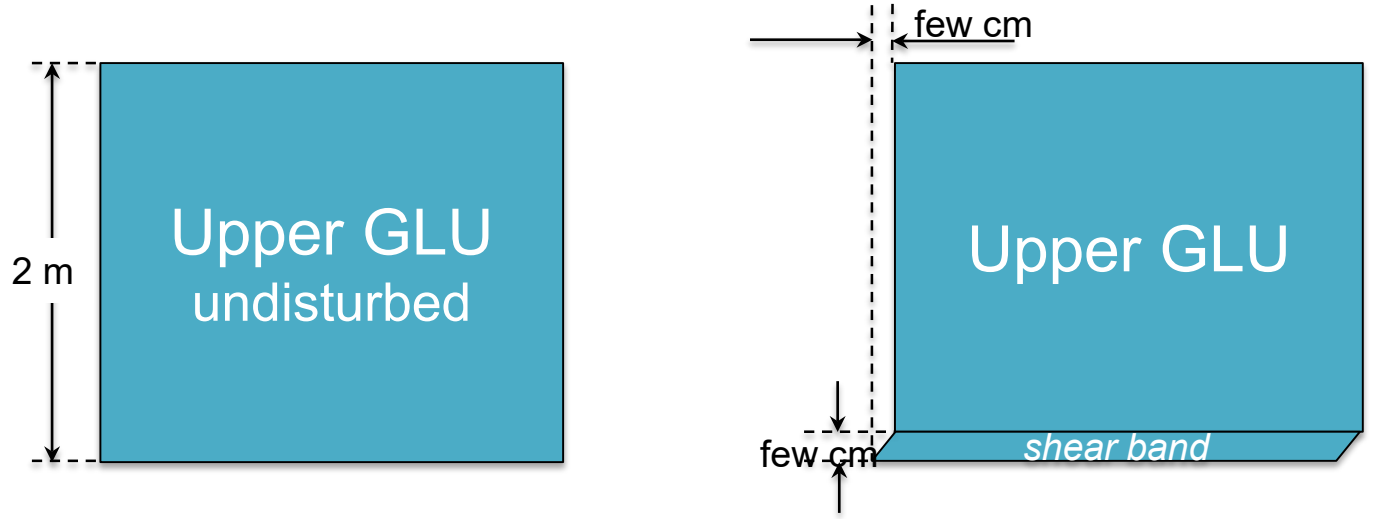


The UPPER GLU

- From lab tests: >60% shear strains = full weakening
- In a 2m layer, this suggests shear displacements of 1.2 m before collapse if straining is uniform



- From field observation: no such deformations happened pre-collapse



GEOMETRY OF FAILURE

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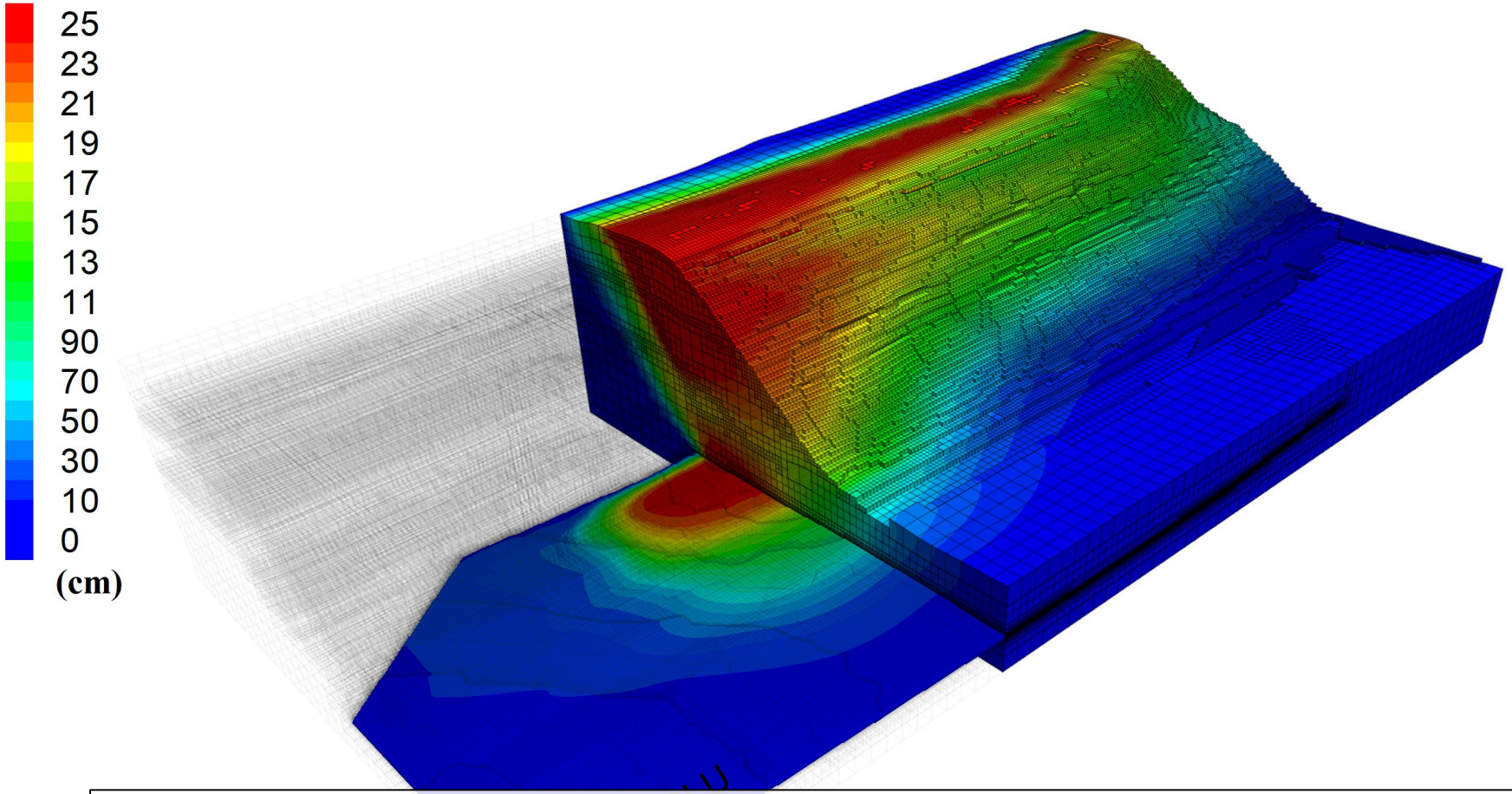
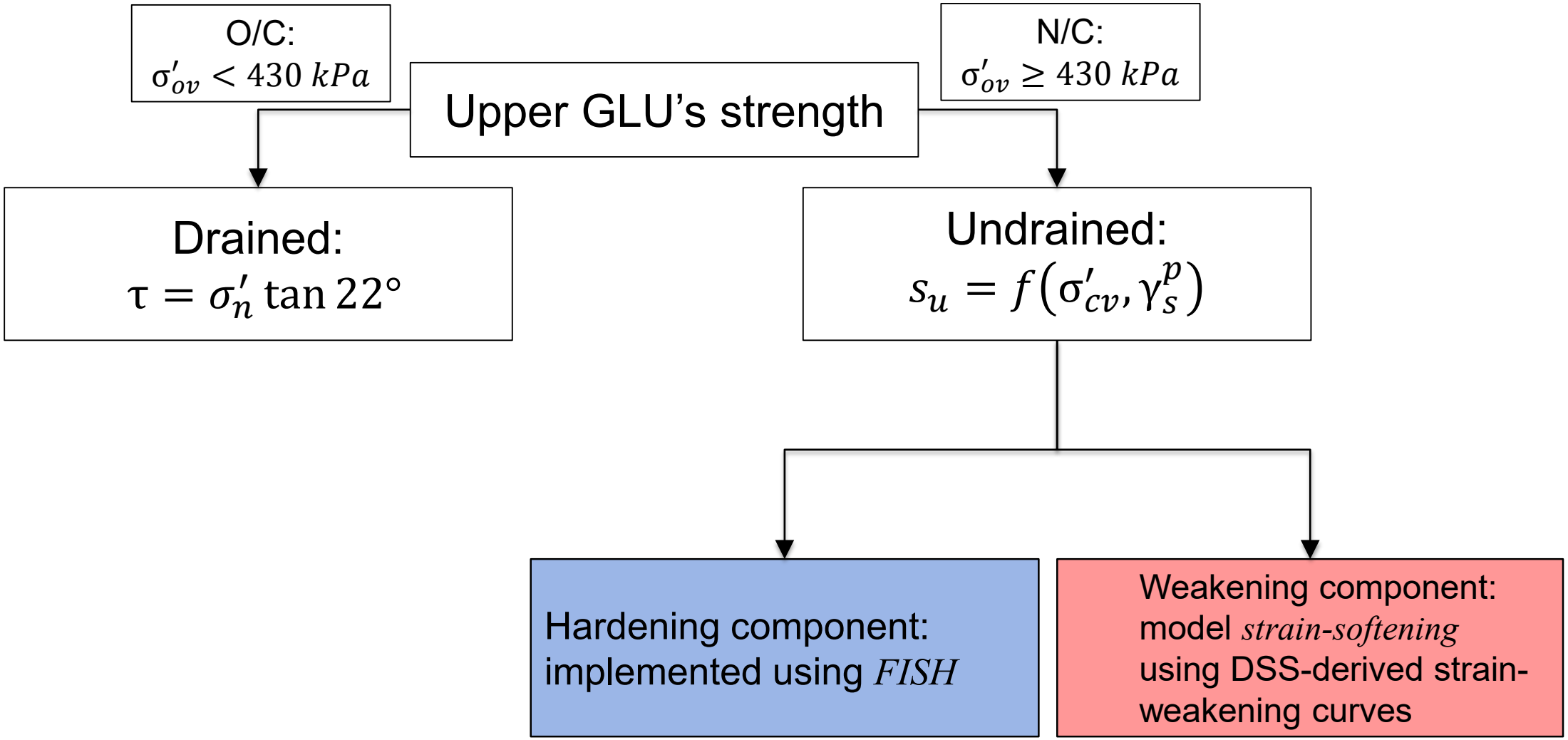
Incremental horizontal displacements during collapse



- 0 < shear band ≤ 12cm
- distinctly asynchronous shear strength mobilization

Upper GLU's CONSTITUTIVE MODEL



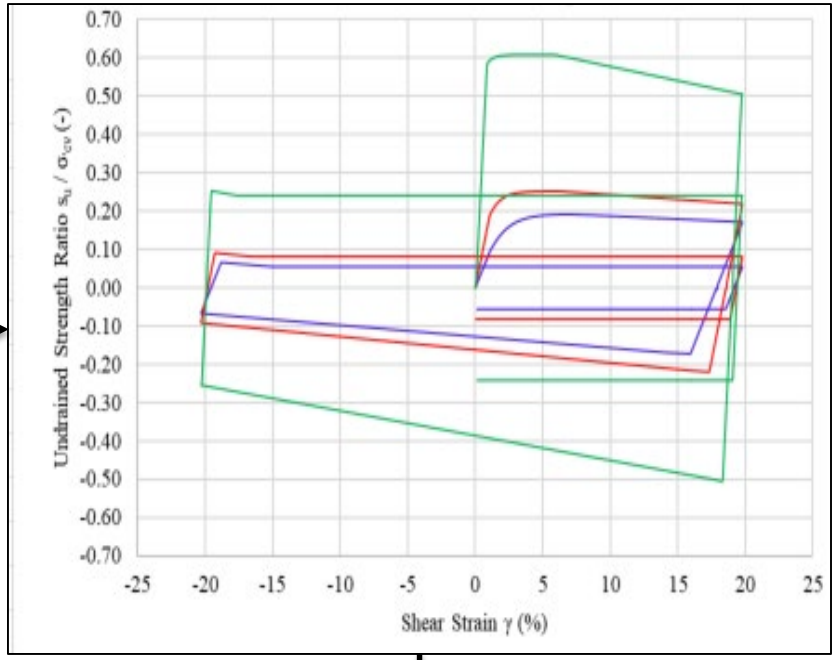
Upper GLU's CONSTITUTIVE MODEL

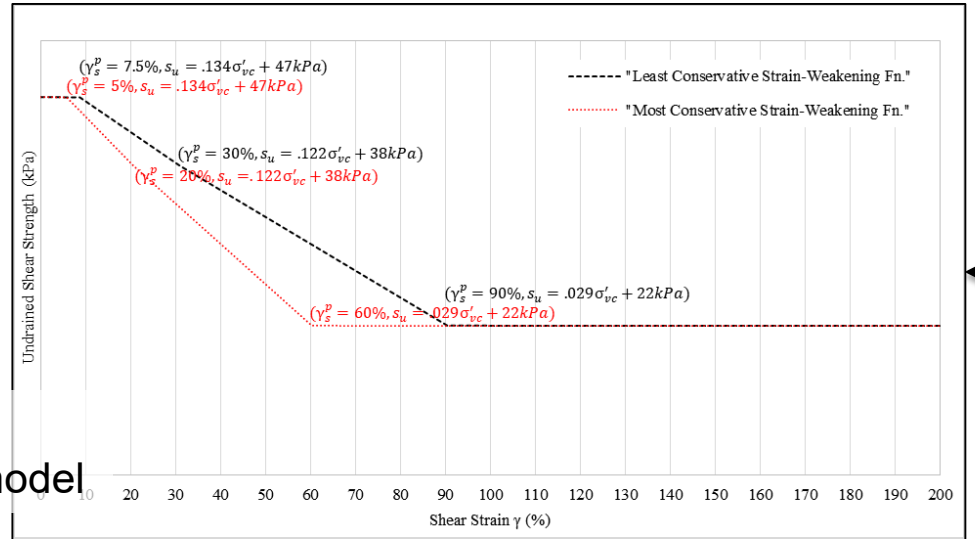
Actual DSS data (from KCB 2015, Fig. 5.23)

KCB's Direct Simple Shear Testing Data

calibration

FLAC3D-simulated DSS data



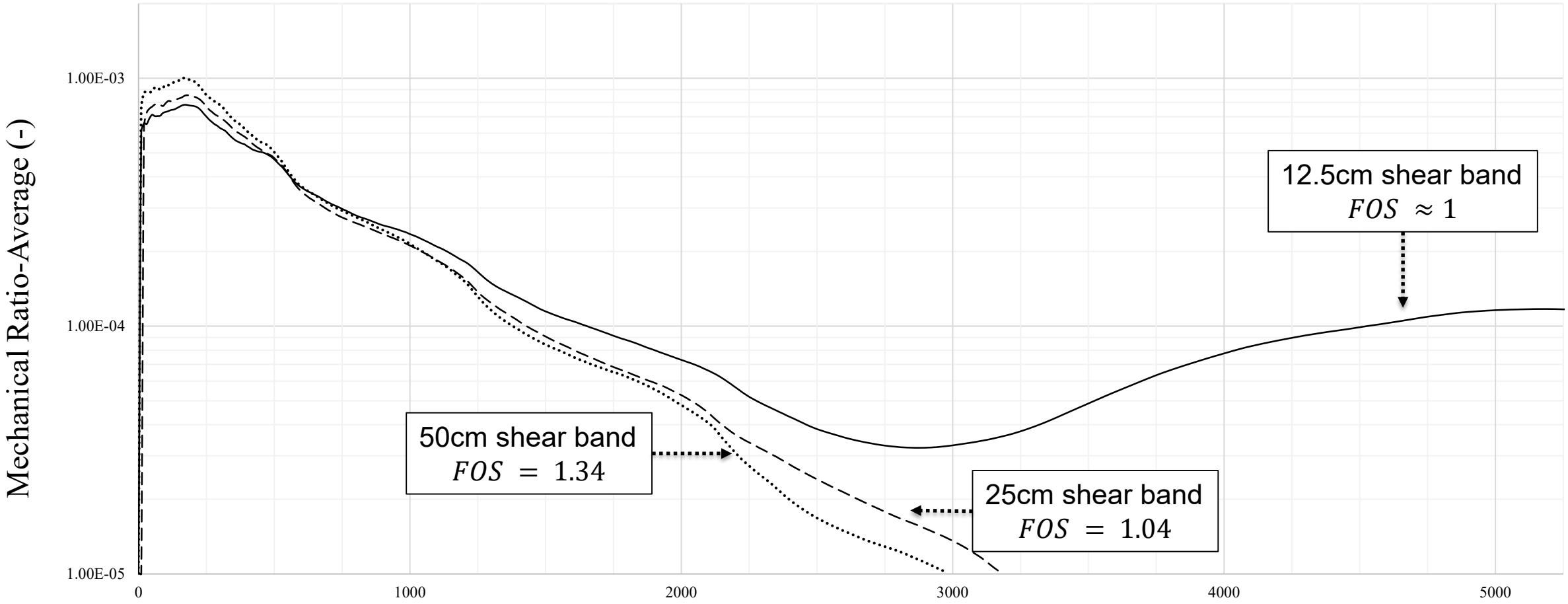


OUTPUT:
strain-weakening curves to be used in model

SCALE EFFECTS

MODEL RESPONSE TO LOADING IN THE FINAL CONSTRUCTION STAGE (9B)

using the most conservative interpretation of the strain-weakening curve in the Upper GLU



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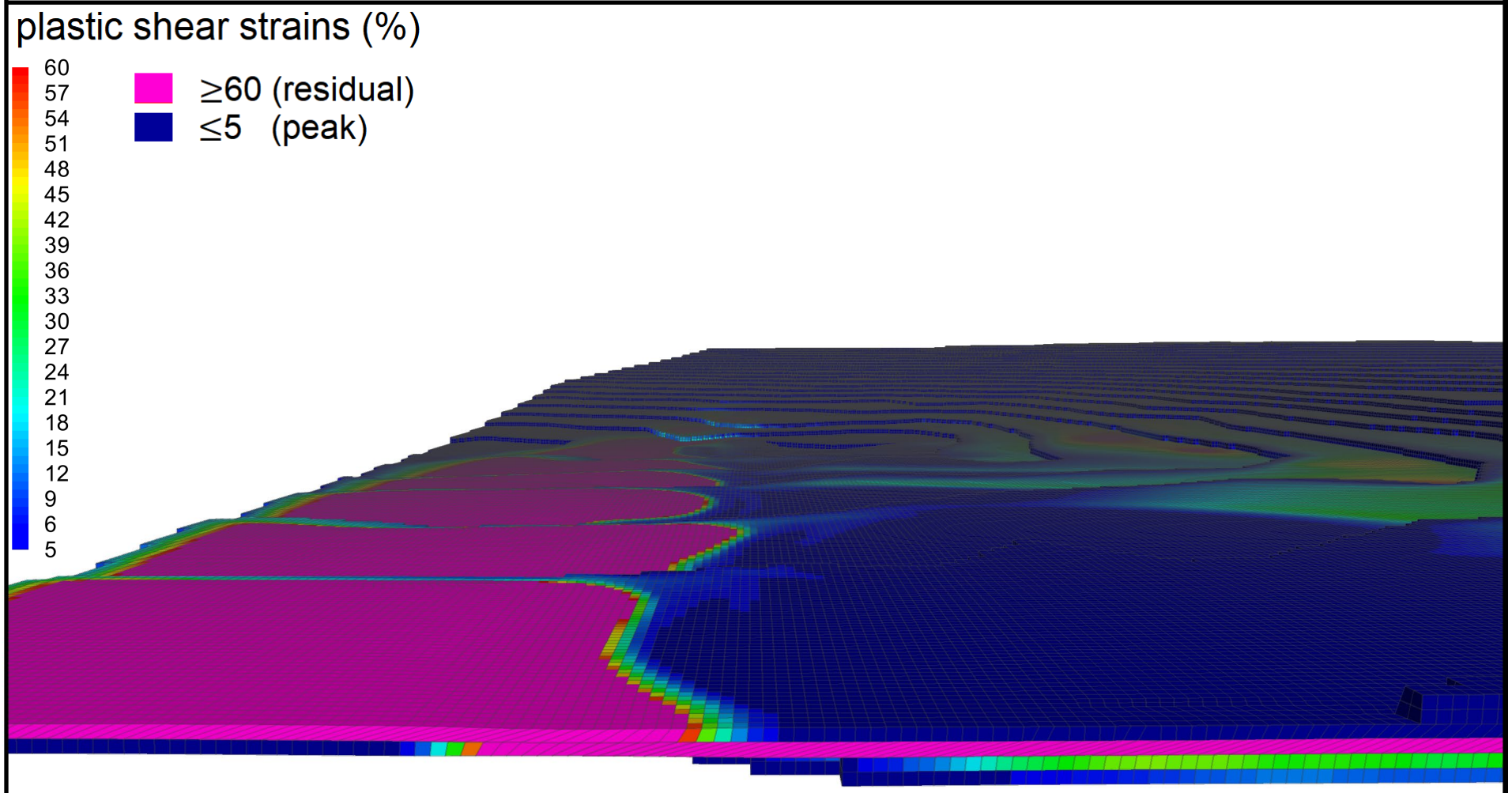
2014 - END OF COLLAPSE SIMULATION



- The correct replication of failure in our finest mesh model can be a result of either:

  (a) Correct shear band thickness (12cm) combined with a **correct choice of strain-weakening curve**

  (b) Excessive shear band thickness combined with an **overly conservative choice of strain-weakening curve**

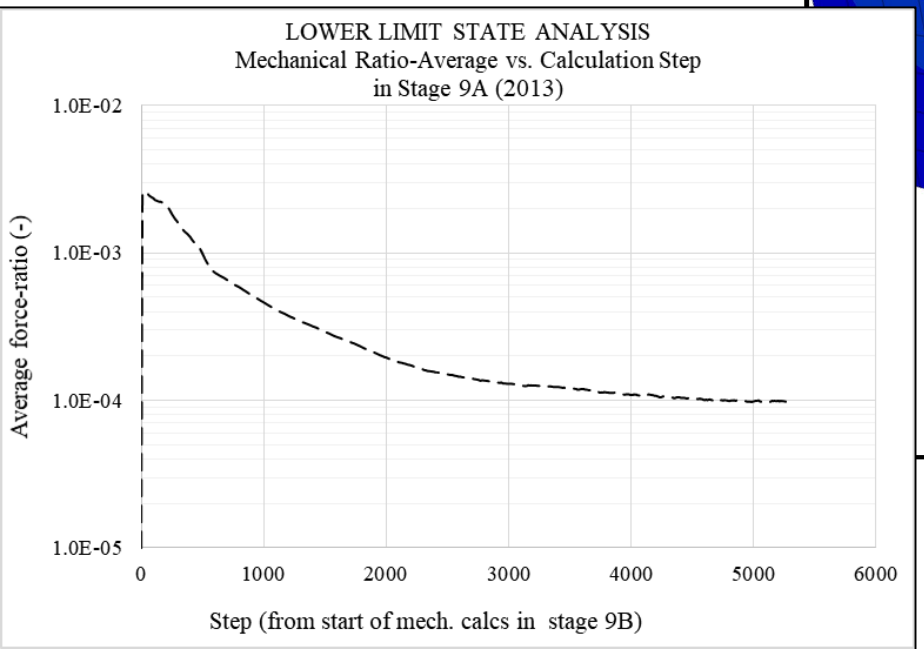
- Further mesh refinement computationally unfeasible

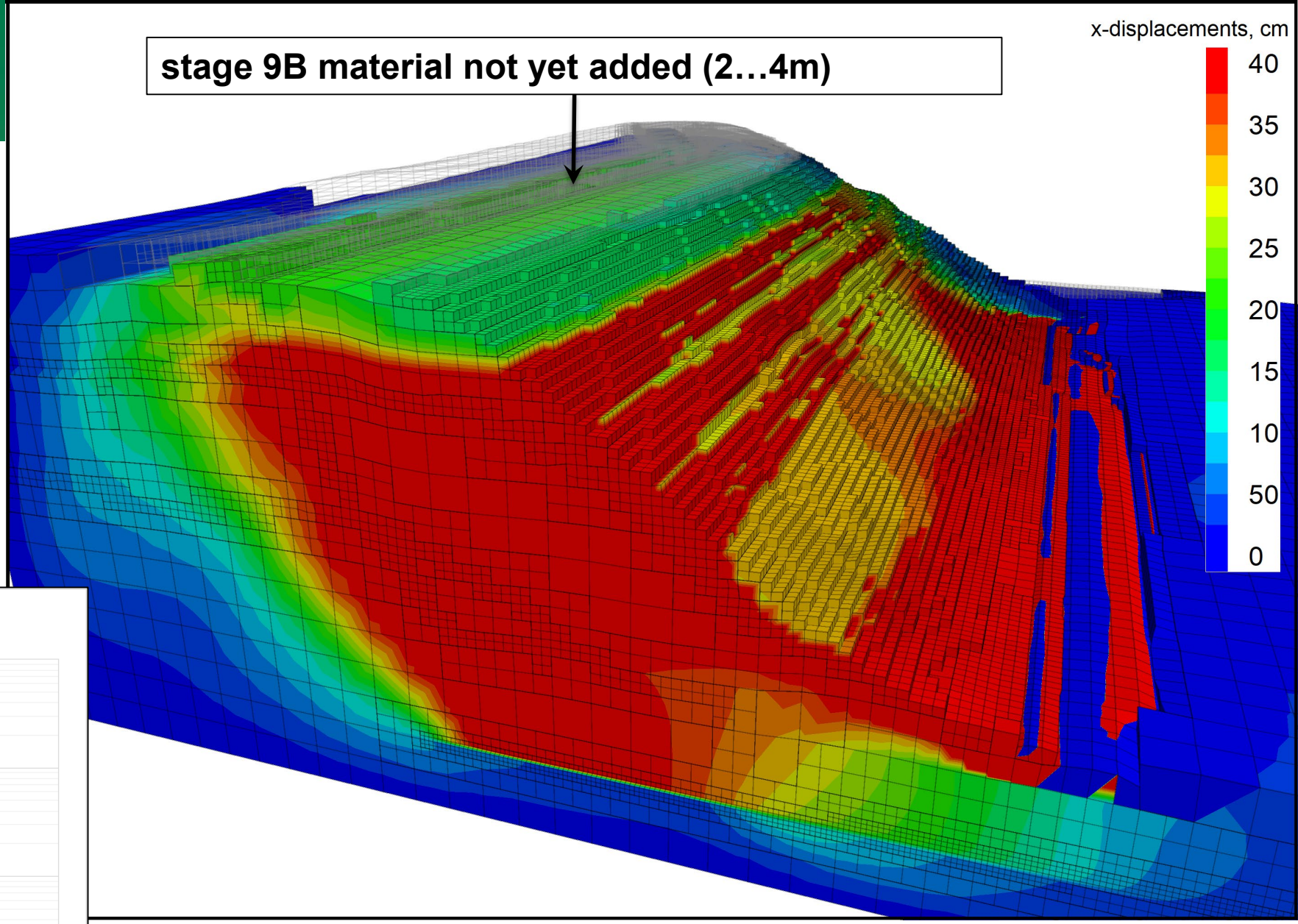
  ➢ Conduct a **LOWER LIMIT STATE** analysis:

  - If mesh could be discretized indefinitely, zone height → zero
  - Such zones, if prone to strain-weakening, would become fully weakened at zero plastic shear displacements
  - Apply “instant weakening” model to regular mesh to simulate “zero thickness” shear band

LOWER LIMIT STATE

Early collapse in stage 9A (2013)





From scale effects: shear band no thicker than 12.5cm

From analysis of lower limit state: : shear band > 0

0 cm < SHEAR BAND ≤ 12.5 cm

ACKNOWLEDGMENTS

We are grateful to Itasca and its Educational Partnership for providing us, free of charge, with FLAC3D software used to complete the study of progressive failure at the Mount Polley TSF

A special thank you goes to **Augusto Lucarelli** for his mentorship through the more challenging modelling aspects of this problem

PHOTO CREDITS

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