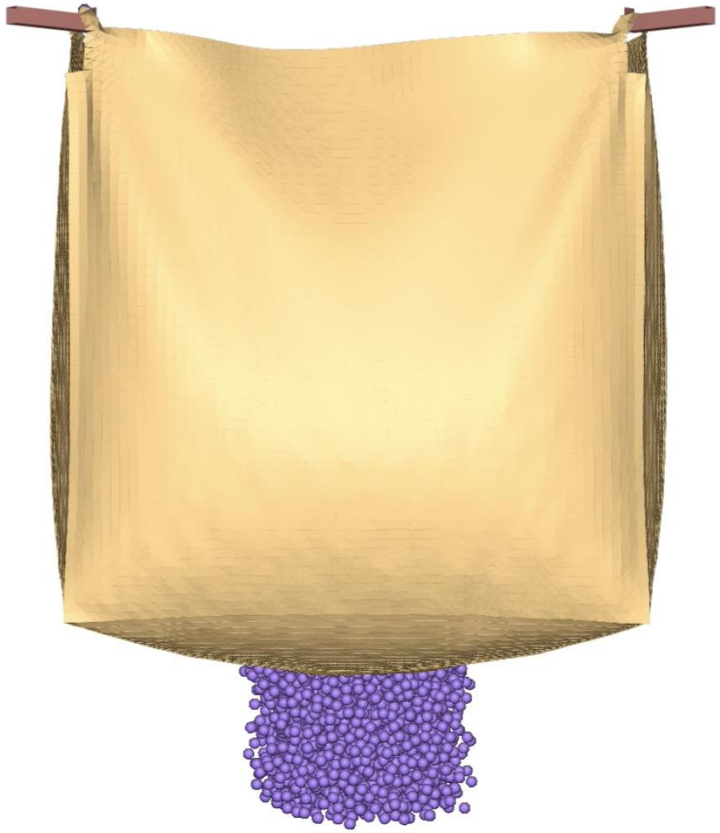

IFPRI Annual General Meeting 2025

Predicting Powder Flow from Containers with Flexible Walls

Centre for Bulk Solids and Particulate Technologies (CBSPT) In association with TUNRA Bulk Solids (TBS)
The University of Newcastle, Australia

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Project Overview

2nd Year Annual General Meeting

1st Year Report has been shared

Milestones and Deadlines have been met

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Progress Update

- Project progress
  - Progress remains aligned with original brief
  - Minor deviations only; all requirements met
  - Year 1 findings delivered and disseminated
- PhD Student Confirmation
  - Candidature confirmed with no major issues
  - No further requirements from the review panel
- Project work presented at:
  - Presented at CHoPS 2024
  - Published in ABHR Article 2024
  - To be presented at DEM10 Conference

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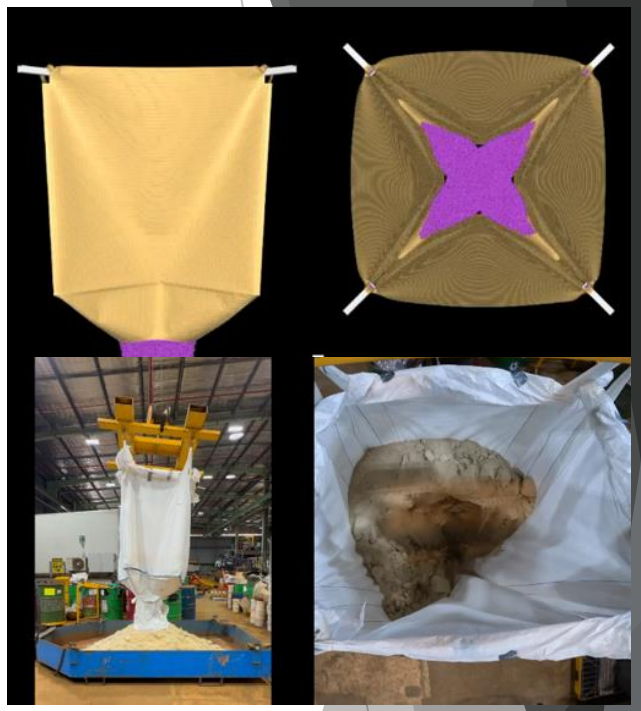
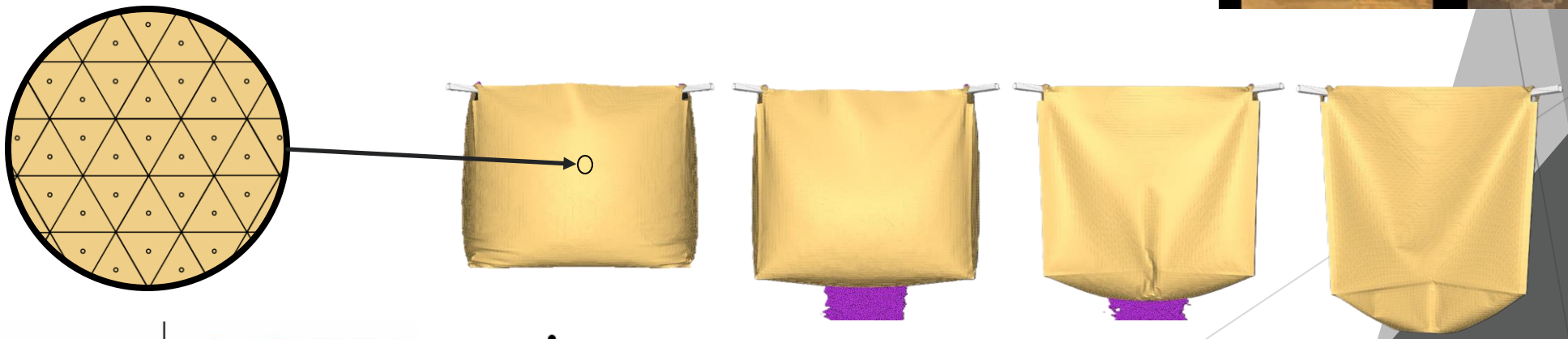
Progress Recap from Last Year

- Initial Experimental work
  - Full-scale bag discharge
  - Design and manufacture of scaled test rig
- Numerical Modelling – DEM
  - Utilised Flexible particles to model FIBC bags
- Preliminary results demonstrated the model's ability to capture bag dynamics and internal flow regime
  - Highlighted the need to investigate the role of flexibility during discharge further
  - Simulations were conducted with ANSYS Rocky 2024R2





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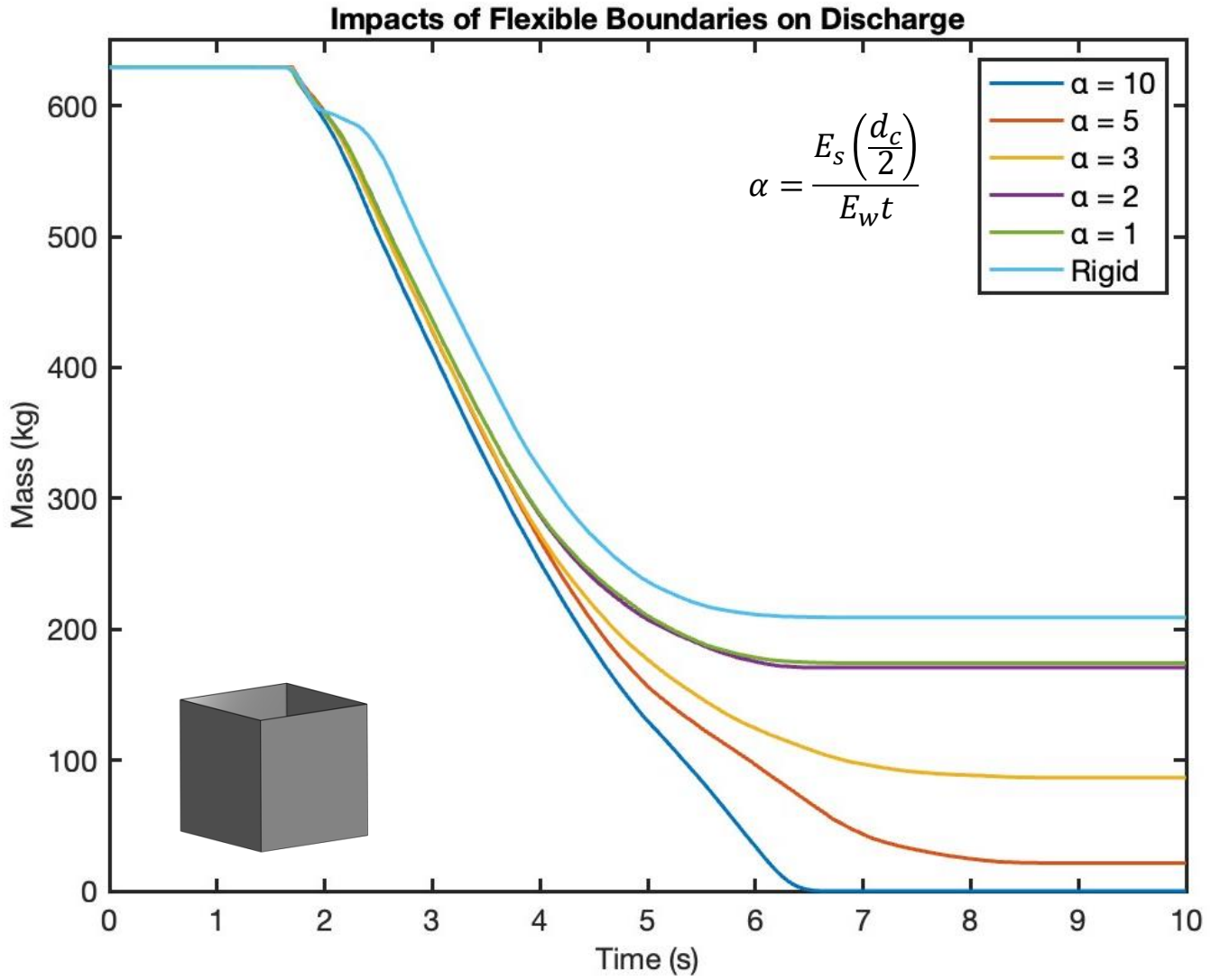
Simulation Results

- Significant variation in discharged mass with flexibility factor change.
- Only container stiffness is modified.
- Observations
  - Bulk material maintains container shape during discharge.
  - The container rapidly loses structural integrity as bulk solid discharges.
  - Container transitions from flat-bottomed bin to one with steep hopper angles.



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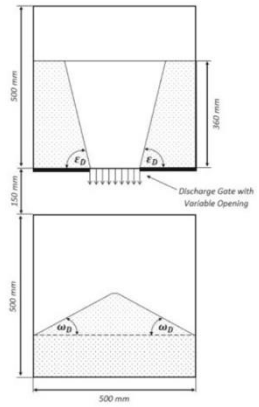
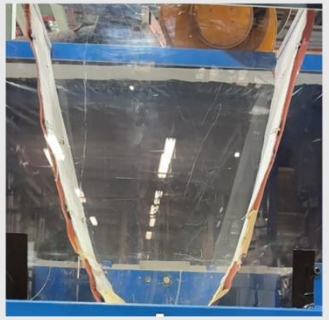
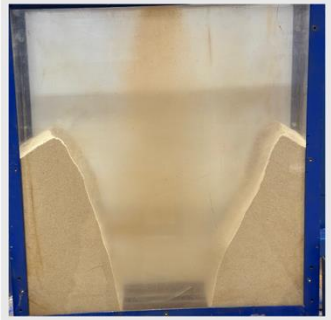
Experimental Testing

Draw Down Rig



Moisture Content	130mm Opening		215mm Opening	
	'2D' Rig	Drawdown	'2D' Rig	Drawdown
2.4%				
7.2%				

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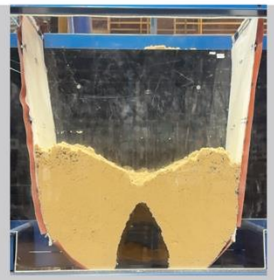
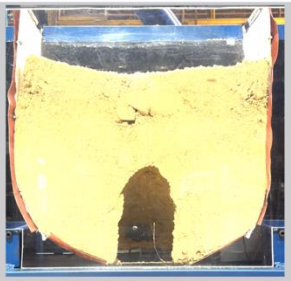
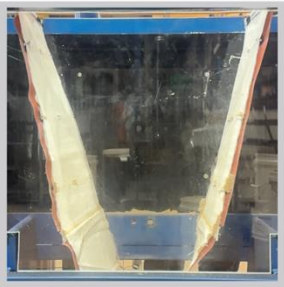
Experimental Testing

Outlet Size	50% Full	75% Full	100% Full
165mm			
190mm			
215mm			

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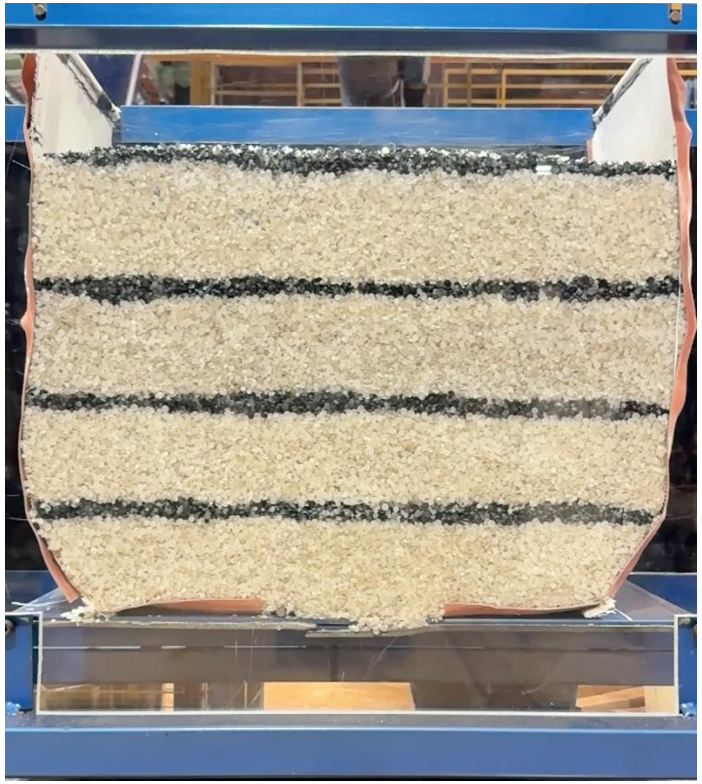
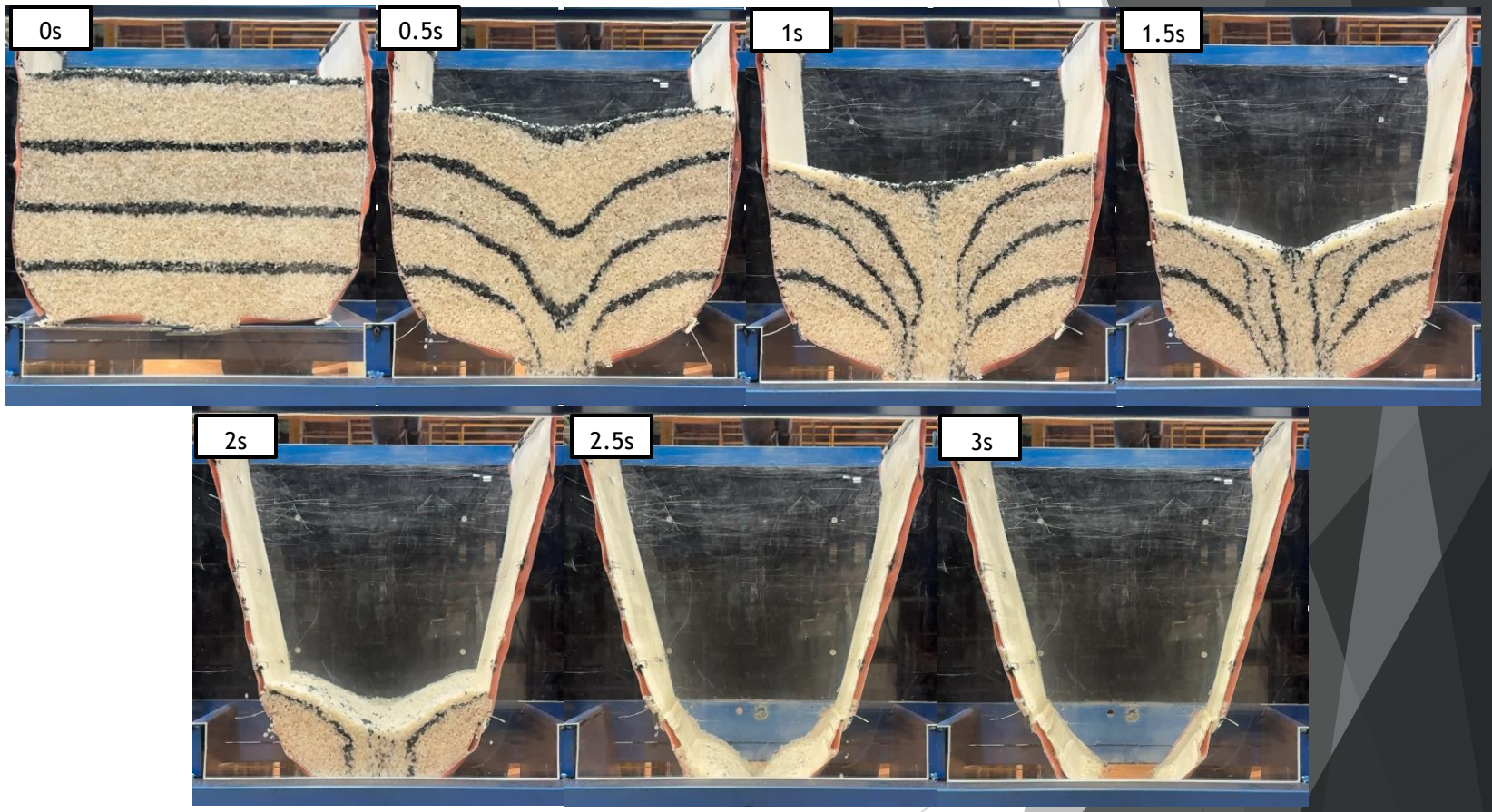
Plastic Beads - Layered Discharge





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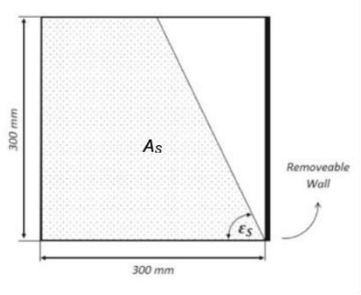
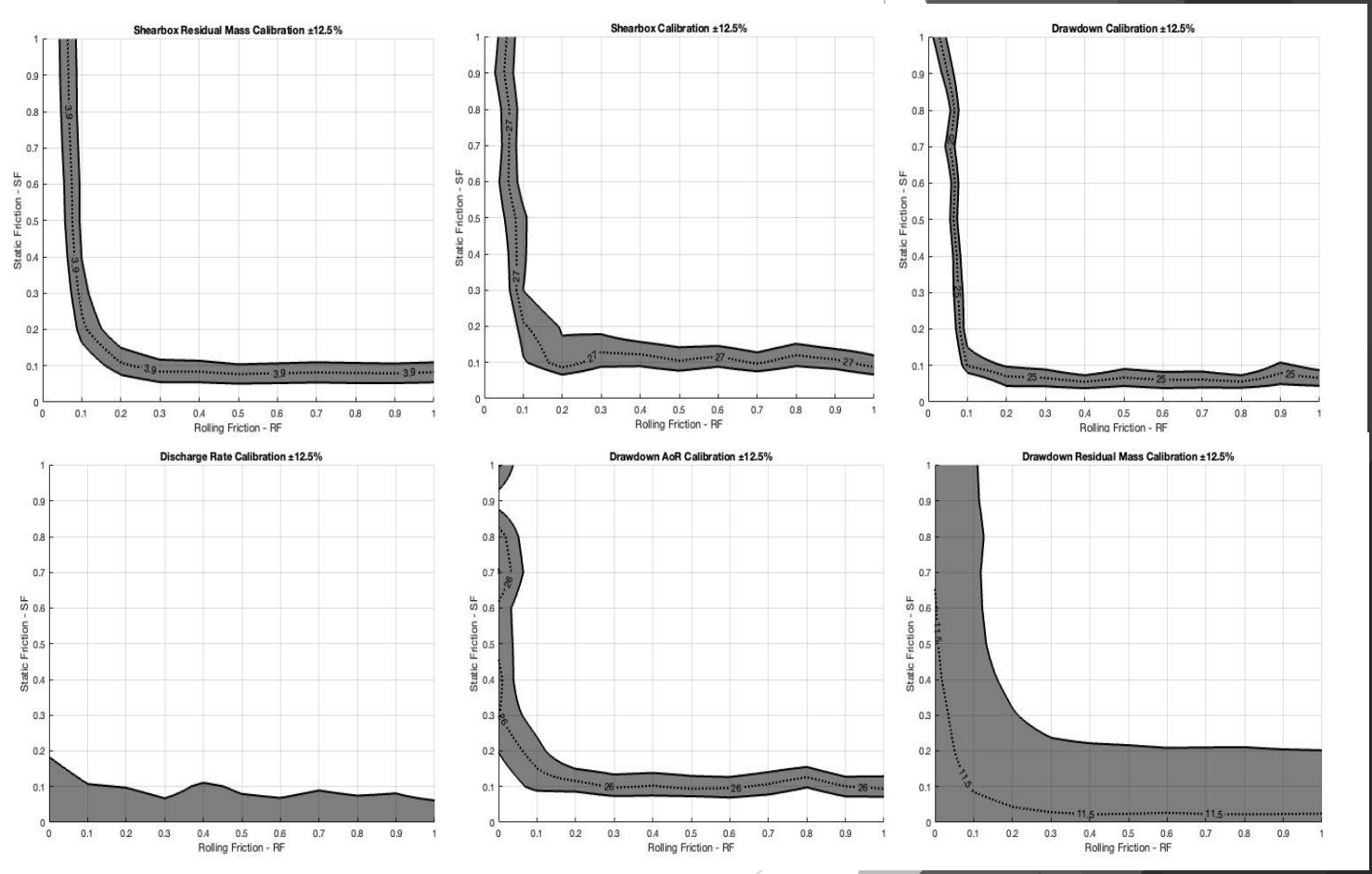
DEM Calibration – Plastic Beads

- Collating the DEM Calibration Tests
  - Shear box Test
    - Shear Angle
    - Residual Mass



  - Drawdown Test
    - Drawdown Angle
    - Drawdown Angle of Repose (Dynamic)
    - Drawdown Discharge Time
    - Drawdown Residual Weight



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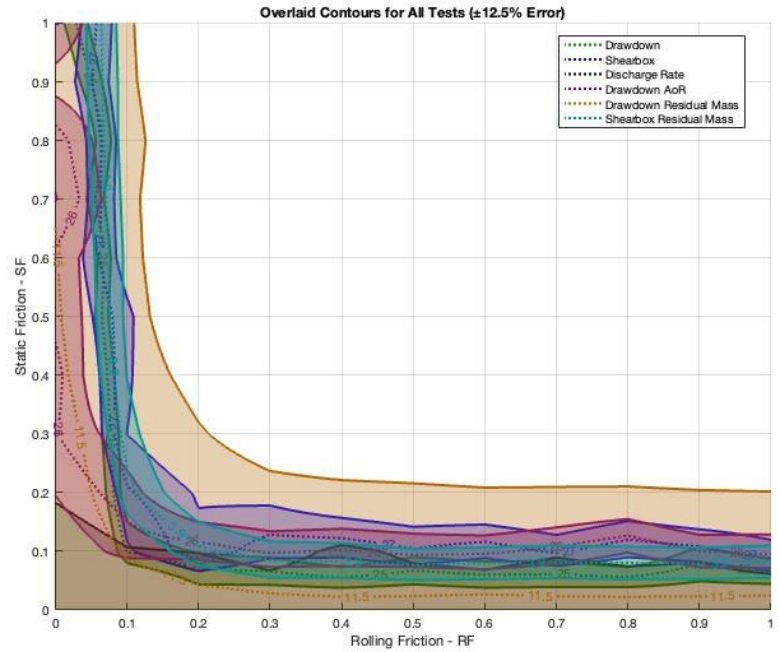
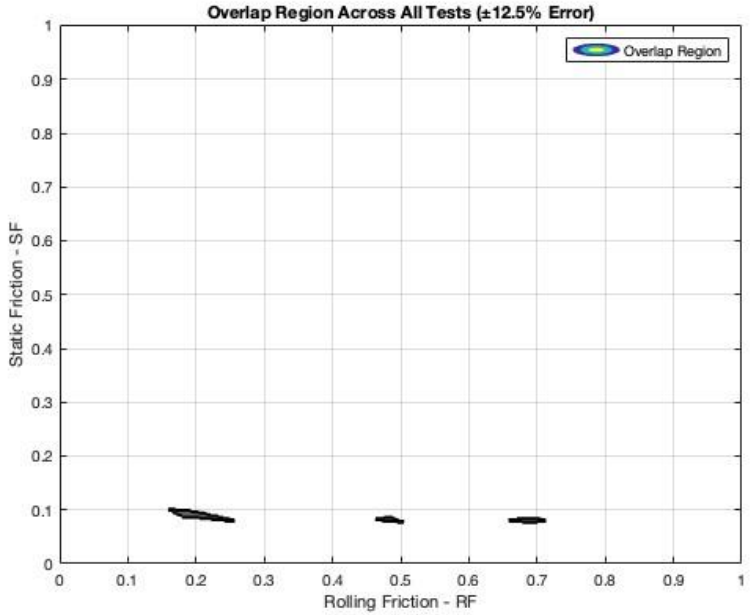
DEM Calibration – Plastic Beads

- Collating the DEM Calibration Tests
  - Shear box Test
    - Shear Angle
    - Residual Mass
  - Drawdown Test
    - Drawdown Angle
    - Drawdown Angle of Repose (Dynamic)
    - Drawdown Discharge Time
    - Drawdown Residual Weight
- Values were chosen in the overlapped region
  - Static Friction - 0.08
  - Rolling Friction – 0.2





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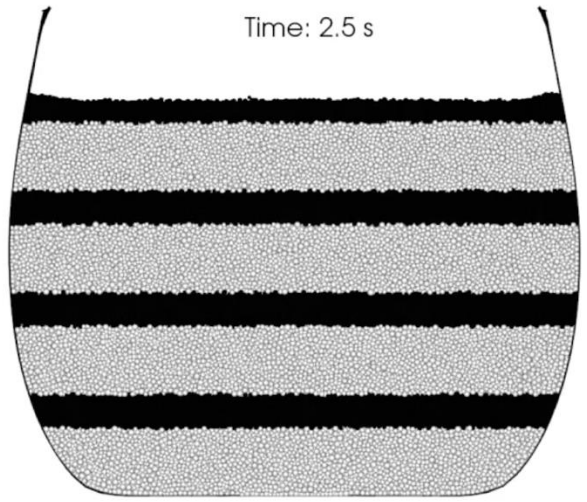
Plastic Bead Discharge Comparison

- Simulation Matches well
  - Too-scale particle size
  - FIBC Bag Simulation Parameters
    - 1mm Thickness (2-ply Fibre)
    - 1.8GPa Young's Modulus (Typical for PP Fibre)
    - Elastic Ratio: 0.05
    - Wall Friction: 0.3
- Moving towards calibration of Cohesive Materials
  - Investigation of different contact models
  - Edinburgh Elastoplastic Adhesion Contact model
  - JKR Adhesion Model & Leeds Contact Model - Rocky



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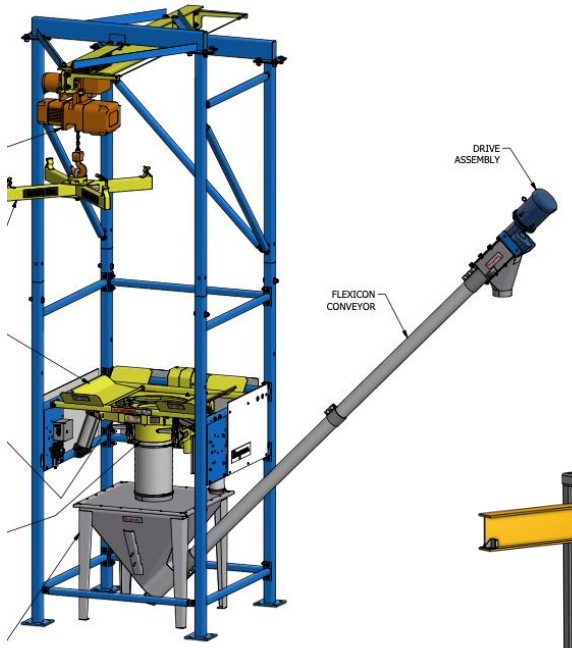
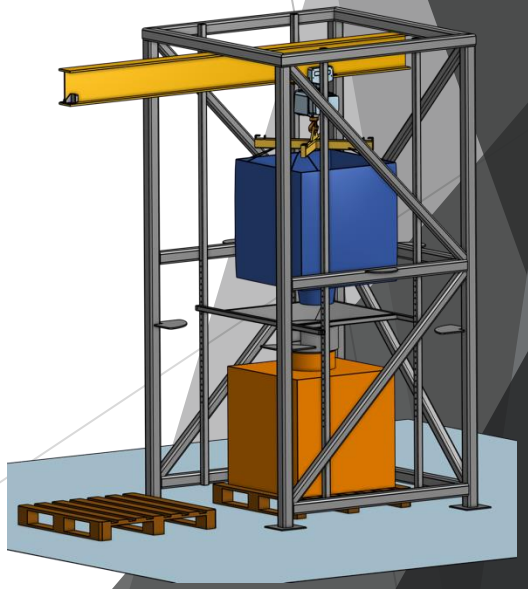
Full-Scale Rig Progress

- Ongoing assessment and design refinement of the 3D rig
  - Evaluating the feasibility of modifying the existing plant
  - Exploring off-the-shelf designs for inspiration
- Design to be completed by the end of Q3
- Feedback and guidance are highly appreciated





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Future Work

- Cohesive Material Calibration
  - Extend calibration to powders exhibiting stronger cohesion
  - Investigate and implement more advanced contact models
- Full-Scale Testing and Validation
  - Calibrate and simulate full-scale FIBC discharge
  - Compare DEM results with experimental discharge data for model validation
- Investigation of Consolidation stresses within the FIBC
  - Investigate funnel flow theory and its application to FIBC
  - Jenike flow theories
- Report 2nd Year Findings

Thank You!

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