AFRIROCK 2025

PIONEERING PROGRESS : THE FUTURE OF ROCK ENGINEERING

Controlling backfill leakage through fractured pillars

SANIRE
SOUTH AFRICAN NATIONAL INSTITUTE OF ROCK ENGINEERING

SAIMM
THE SOUTHERN AFRICAN INSTITUTE OF MINING AND METALLURGY

Controlling tailings backfill leakage through fractured pillars

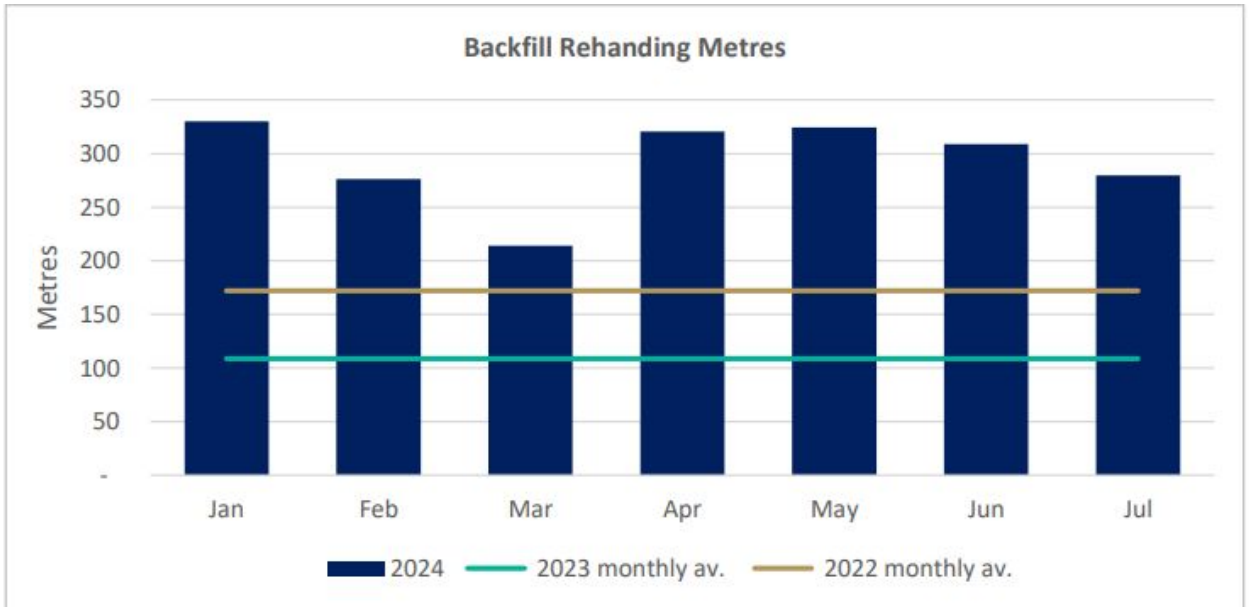
George Mphike
Donald O'Connor
Sifanekiso M. Sibanda

Topics

- The problem
- Mine Operations
- Potential solutions
- Selected solution – gel the backfill
- Laboratory investigations
- Underground tests
- Results
- [illegible]

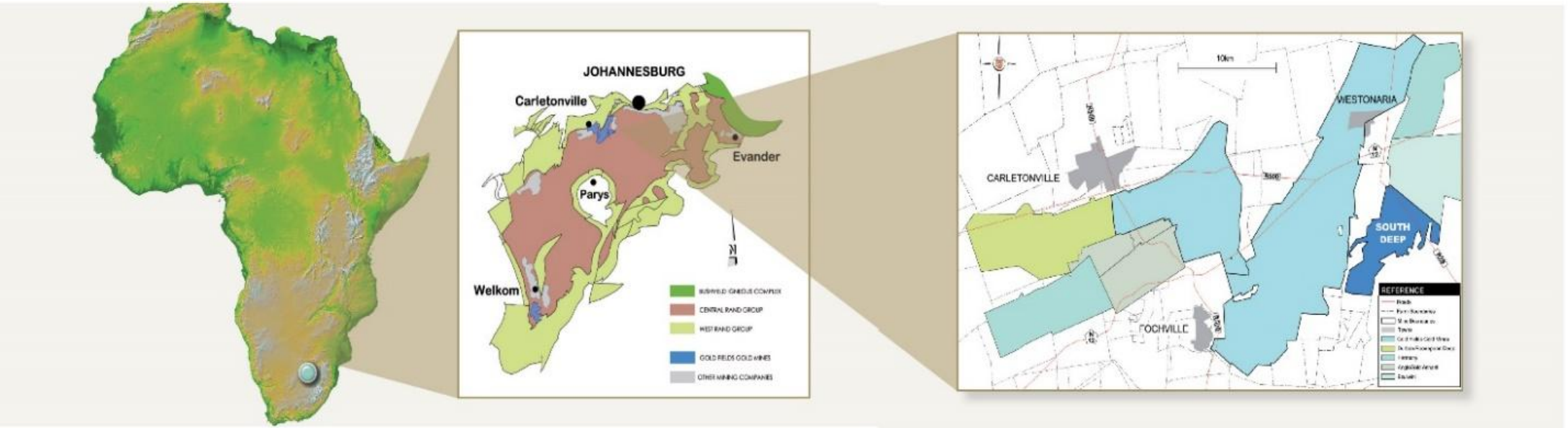
THE PROBLEM

- Backfill slurry leaking though fractured pillars
  - Accumulating in the active workings
- Required re-handling, increasing working costs



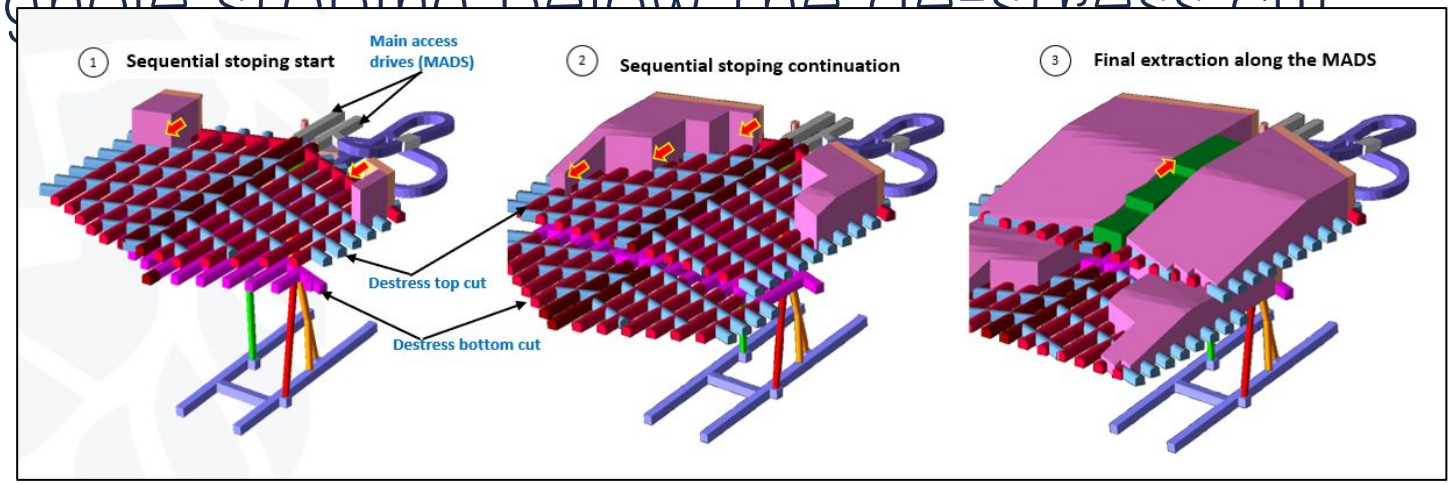
LOCATION

- South Deep Gold Mine
- 45 km West of Johannesburg, South Africa



MINING OPERATIONS

- Up to 60 m thick quartzitic orebody at 3000 m depth
  - Challenging combination of massive mining at great depth
- Unique mechanised mining method developed
  - Horizontal, overlapping de-stress cuts and 7 m wide crush pillars
  - Longhole stoping below the de-stress cut

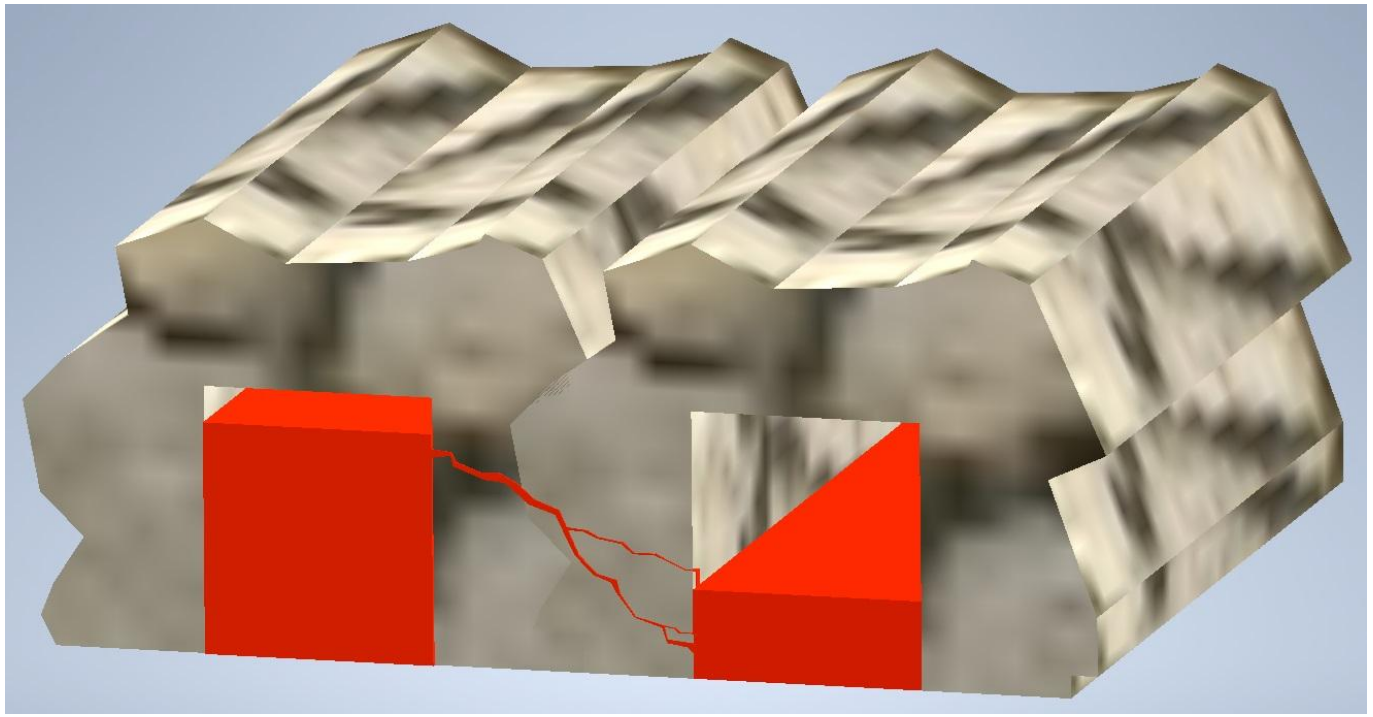


BACKFILLING

- Destress drives are backfilled, between pillars
- Backfill is semi-classified tailings with 8% cementitious binder
  - Relative density ~ 1.75
  - Target strength at 28 days: 1.2 MPa
  - Fines (< 10 µm): 10% - 20%
- Slurry prepared on surface and gravity flows to underground
  - ± 60 000 m^3 placed per month
  - Individual discharge flows: 60 -120 m^3/hour

BACKFILL LEAKAGE PROBLEM

- Pillars at 3 000 m depth are intensely stress fractured
- Fractures provide fluid paths through the pillars –
- Freshly-placed backfill slurry leaks through the pillars



POTENTIAL SOLUTIONS

Create an internal barrier

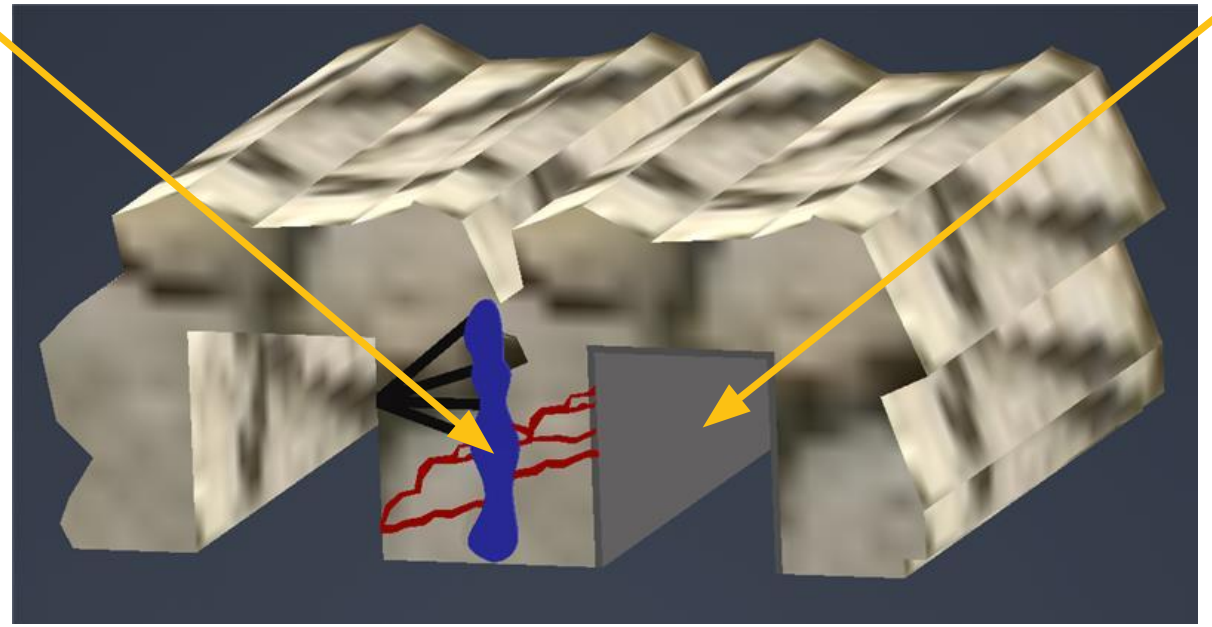
- Drill into pillars
- Inject grout or resin to seal fractures

- But
  - No certainty of sealing.
  - High equipment and materials requirement.
  - Delayed filling

Surface lining of drives

- Spray liner (TSL), or geofabric

- But
  - High equipment and materials requirement.
  - Delayed filling



SELECTED SOLUTION

Add gelling agent to the backfill slurry

- Injected near the discharge points
  - Causes viscosity rise within 1 – 10 minutes
  - Gelled slurry is too viscous to permeate through fractures

- System was originally developed in ~ 1990 ("Fillgel + Fillcem")
  - Widespread application in SA backfilling operations
    - Used to stop water loss and ensure tight filling in flat stopes

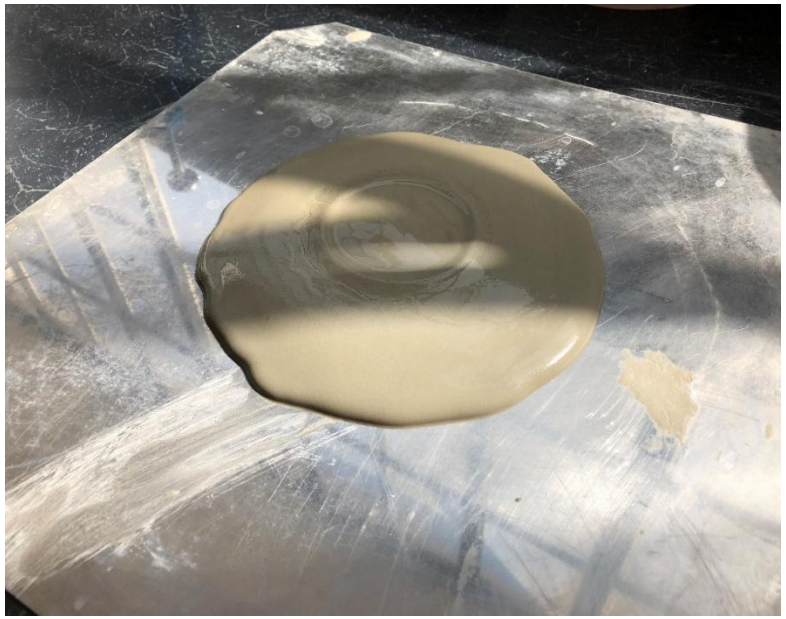
INVESTIGATION PROGRAM

- Measure the gelling action of the additive
- Determine the effect of gelling agent on strength development
- Optimise addition rate of gelling agent
- Confirm reduced permeation through fractured rock
- Develop a dosing system

MINOVA

GELLING ACTION – FLOW CONE/SLUMP TEST

Gelation after 2 – 8 minutes



0% gelation agent

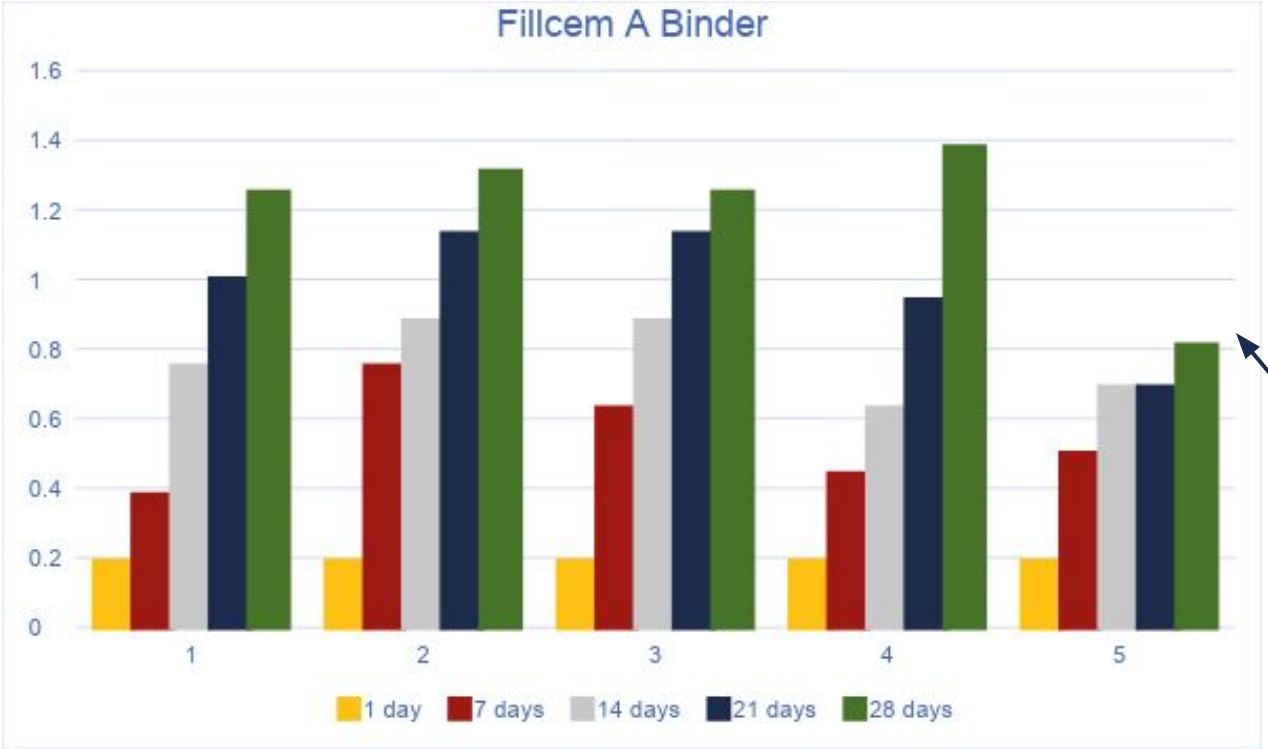
0.5% gelation agent

1% gelation agent

Gelation agent dosage is percent of binder content

EFFECT ON FINAL STRENGTH

UCS (MPa)



Water bleed	Percent gelation agent				
	0.0	0.5	1.0	1.5	2.0
% water accumulation after 24 hours	1.10%	0.30%	0.30%	0.30%	0.70%

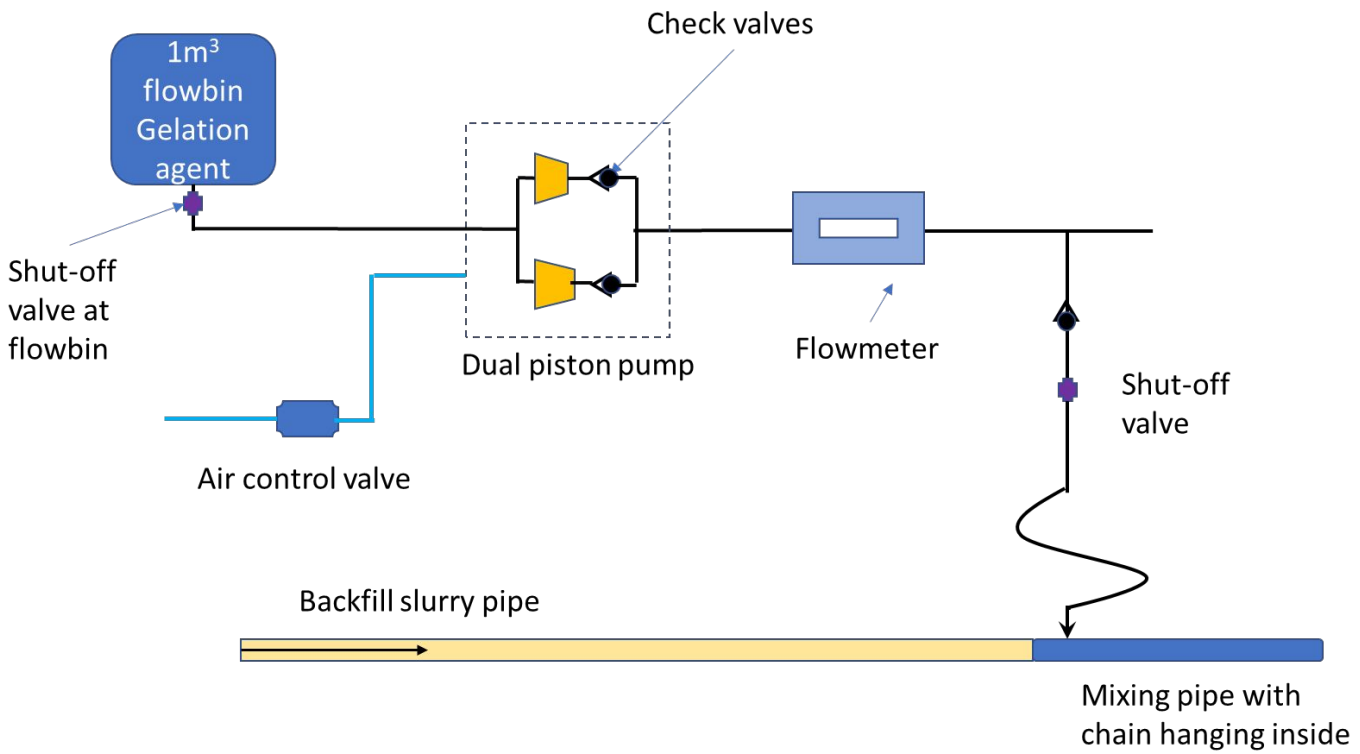
Syneresis ?

PERMEATION IN PACKED COLUMN

Distance in 30 minutes

- 0% gelation agent: 0.72 m
- 1% gelation agent 0.25 m

DOSING SYSTEM



UNDERGROUND TESTS

- Tests carried out in July – August 2024
- Backfill pipe split and mixer inserted 15 – 20 m before discharge
  - Flow rate 60 – 80 m^3/hour – but not accurately known
  - 1% addition rate was approximate

- Visible backfill leakage stopped ~ 10 min after injection started
- Confirmed by stopping injection, then starting again

UNDERGROUND INJECTION PIPE

Injection pipe

Leaked backfill slurry on footwall

RESULTS

- Addition of gelation agent effectively stopped backfill leakage
- System was adopted for regular use
- Backfill re-handling problem was solved.

MINOVA