The Relationship between Confining pressure and Geomembrane strain

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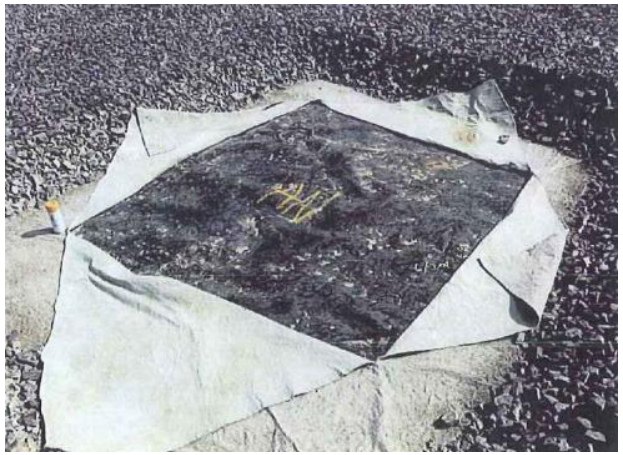
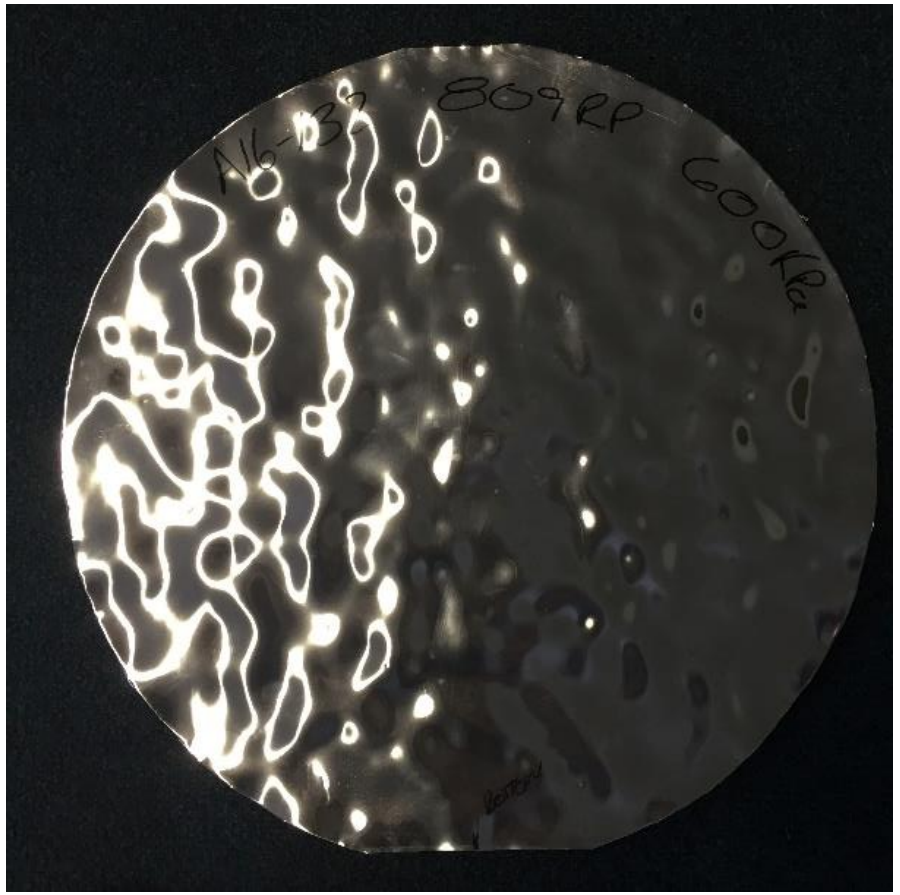
GEOANZ #1 ADVANCES IN GEOSYNTHETICS
7–9 JUNE 2022 | BRISBANE CONVENTION & EXHIBITION CENTRE



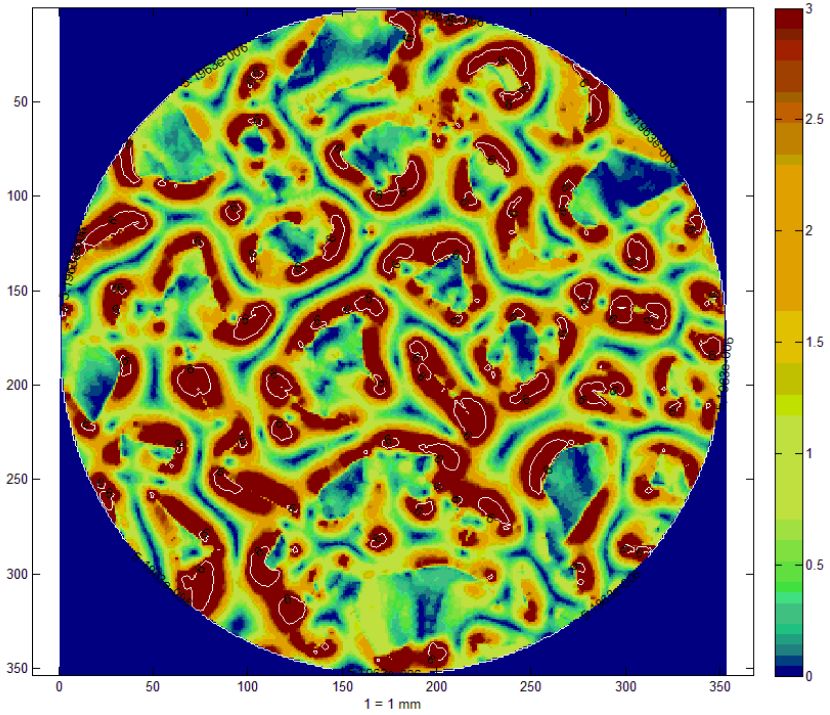
GEOANZ #1 ADVANCES IN GEOSYNTHETICS

7–9 JUNE 2022 | BRISBANE CONVENTION & EXHIBITION CENTRE

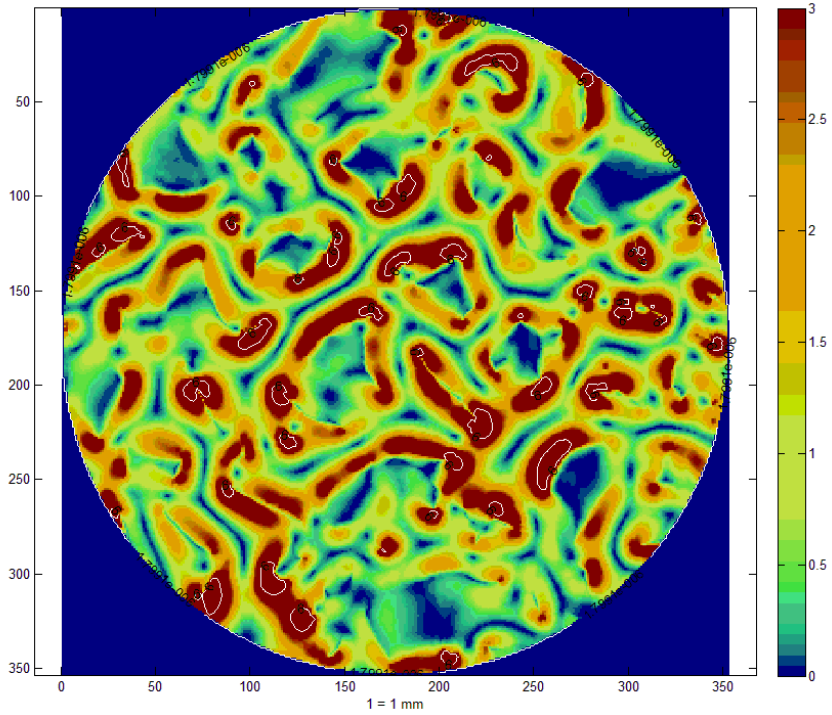
- Geotextiles reduce strain



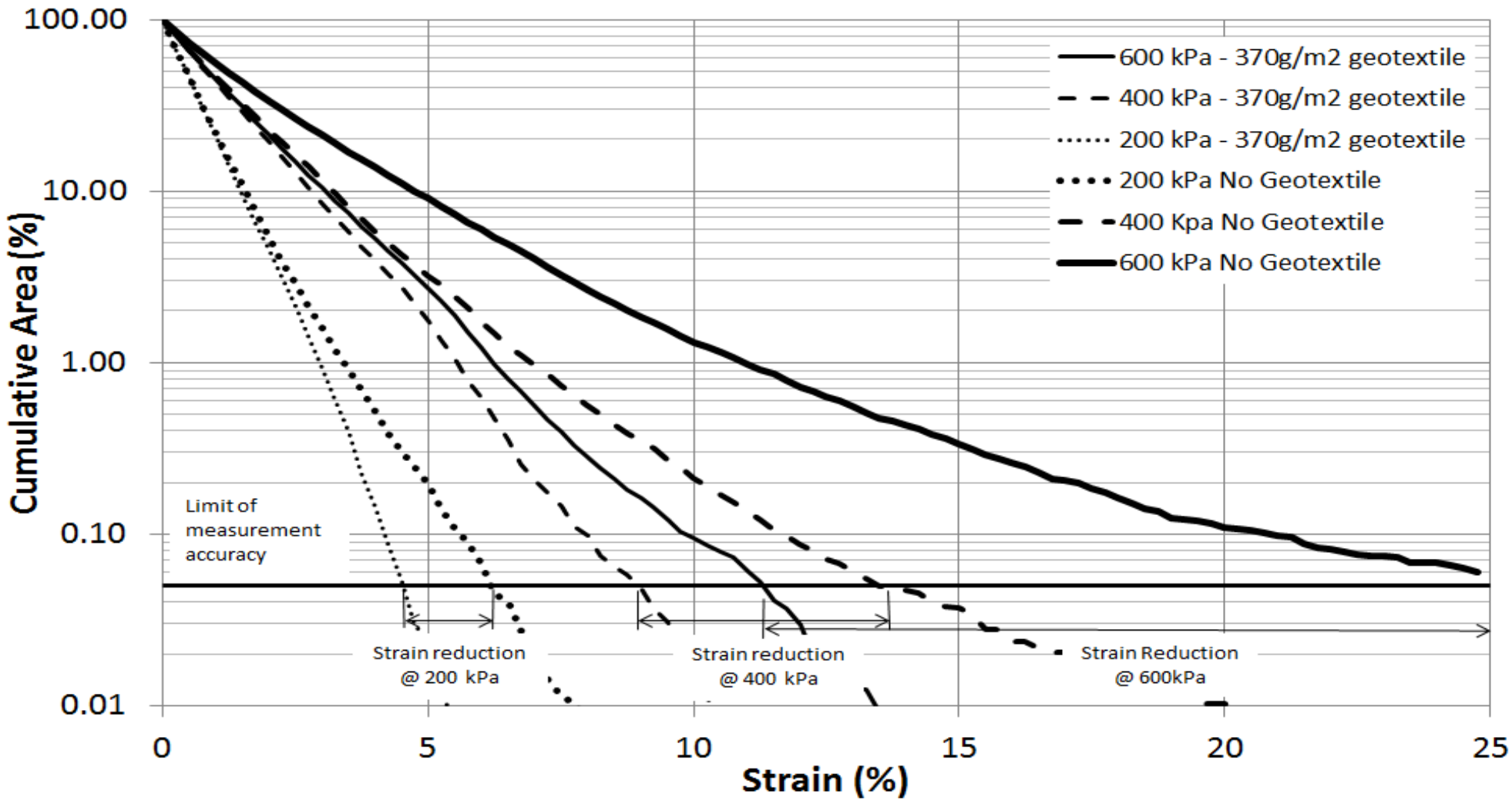
- Graphical Output
  - Strain Distribution



No geotextile protection



370g/m^2 Geotextile protection


100.00
10.00
1.00
0.10
0.01
Cumulative Area (%)
0
5
10
15
20
25
Strain (%)
600 kPa - 370g/m2 geotextile
400 kPa - 370g/m2 geotextile
200 kPa - 370g/m2 geotextile
200 kPa No Geotextile
400 Kpa No Geotextile
600 kPa No Geotextile
Limit of measurement accuracy
Strain reduction @ 200 kPa
Strain reduction @ 400 kPa
Strain Reduction @ 600kPa

- Testing
- The results depend on a number of variables which are built into the tests
  - Gravel
  - Geotextile
  - Subgrade
    - Rubber or Clay
    - GCL (level of hydration)
  - Recording plate
    - Position
    - Materials
- Good science = limited variables

Method ASTM D5514

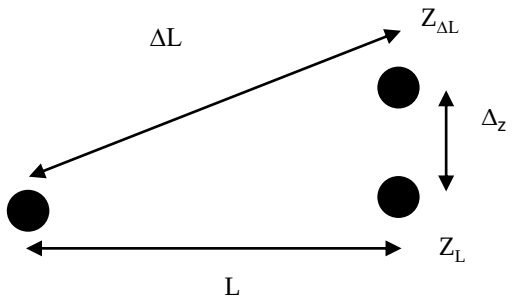
- **Advantages**
  - Simple test assembly
  - Repeatable testing
- **Limitations**
  - Placement ≠ site
  - No influence of subgrade (conservative)

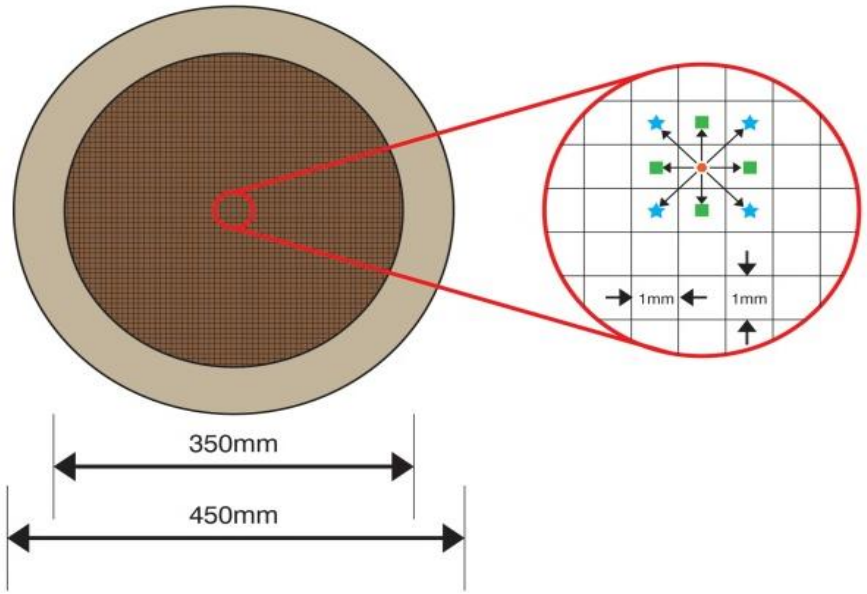
Strain Calculation - Australia

Methodology

- Area divided into grid
- Average height assigned
- Relative strain between neighbouring squares calculated
- Max strain assigned to that area

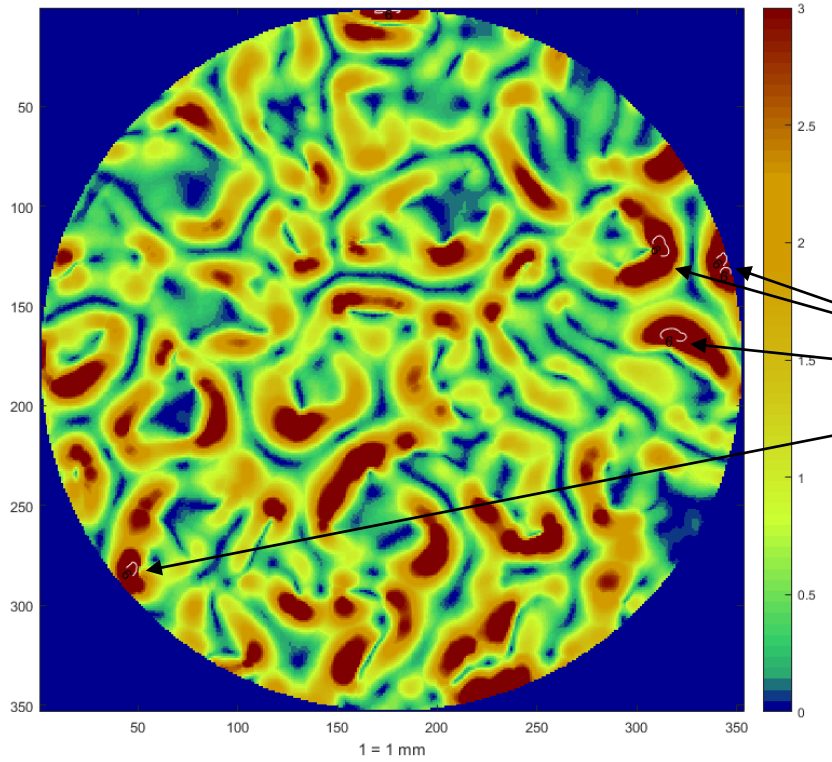
$$\varepsilon\,(\%) = \left[\frac{\sqrt{L^2+\Delta z^2}}{L} - 1\right] \times 100$$





Strain Interpretation

- Strain image
  - Highlights strains across surface

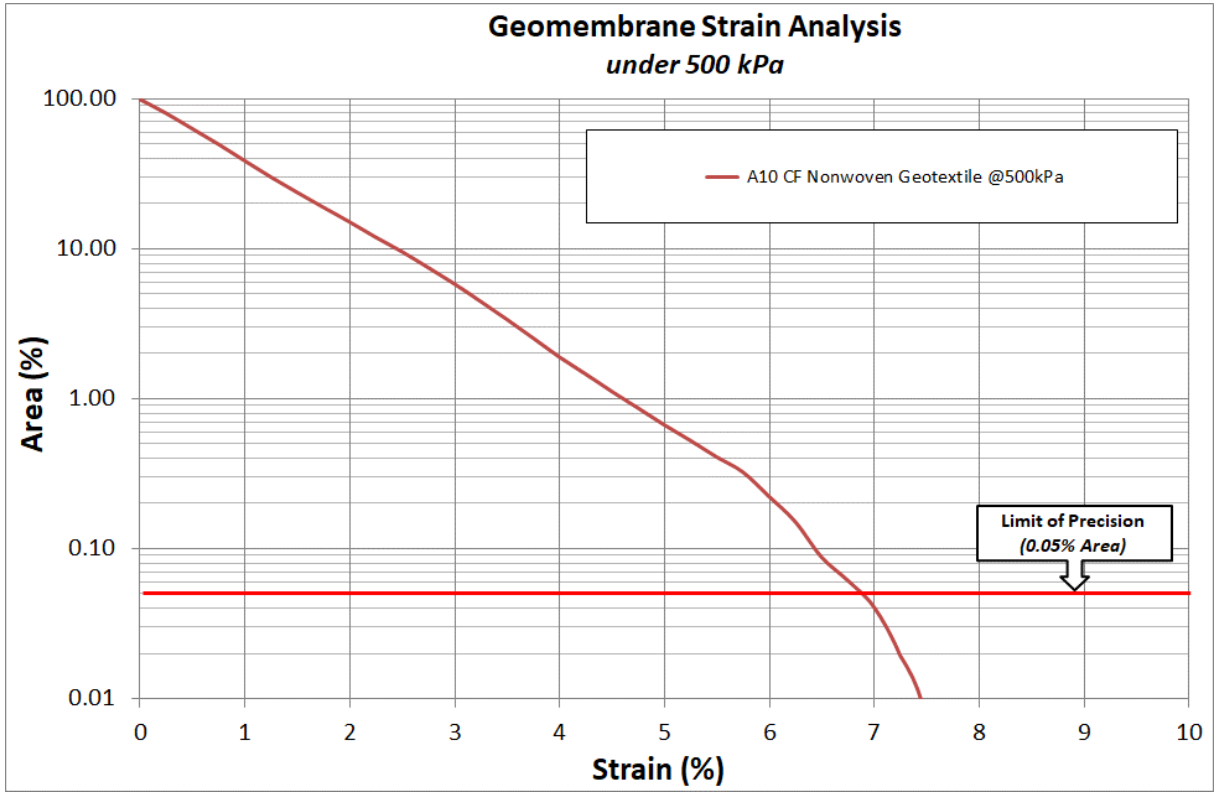


Multiple points where strain exceeds 3%

Multiple points where strain exceeds 6%

Strain Interpretation

- Strain graph
  - Based on total area



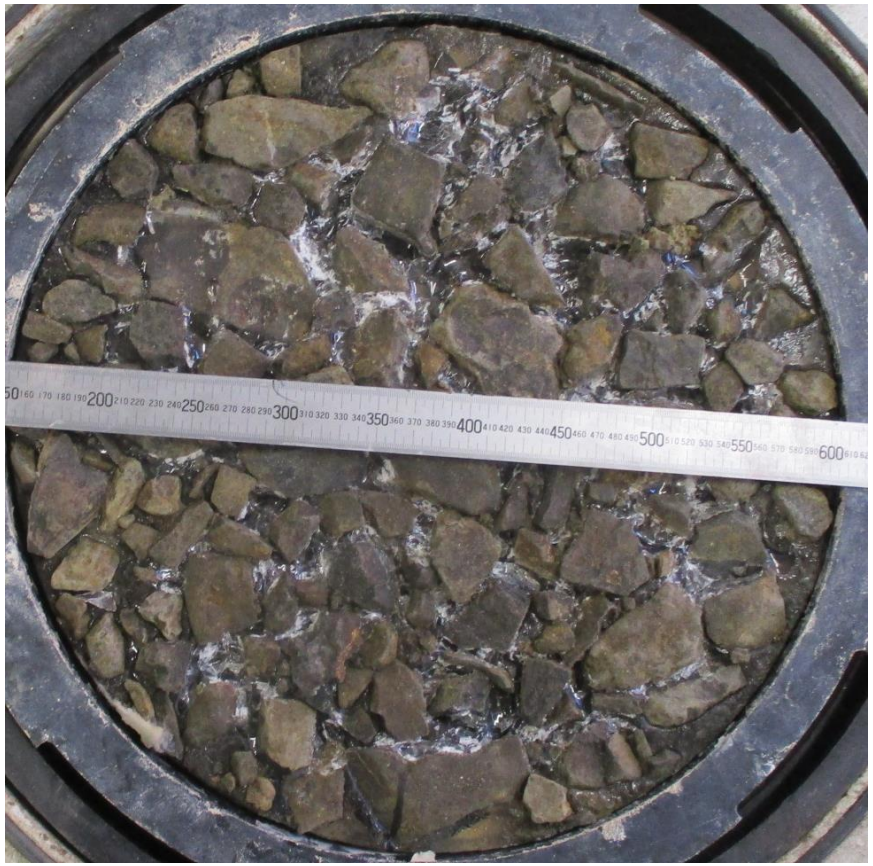
Method Comparison – Australia

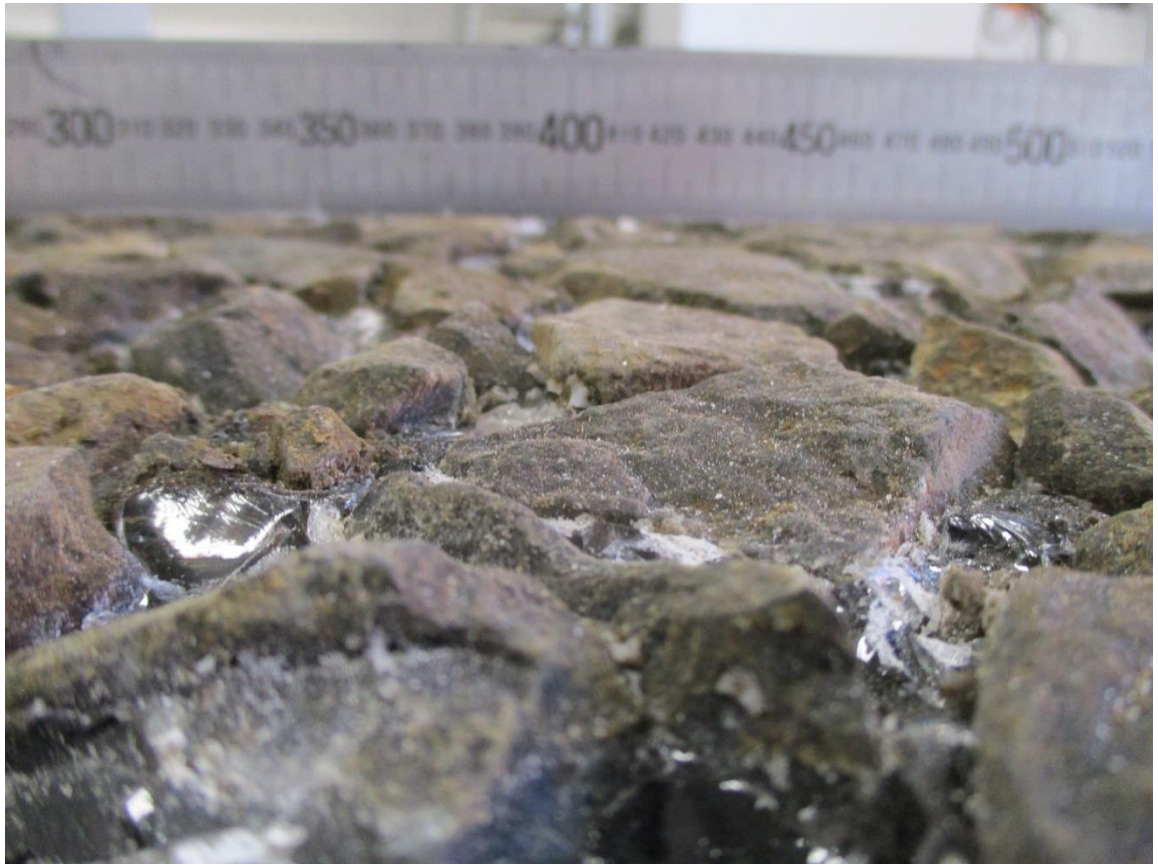
Gravel “Pizza”

- Manufactured to mimic construction
  - Multiple layers of resin
  - Gravel
  - 10mm Silicone
  - Geotextile
- Remove silicone
- Remove resin filling voids

- Concerns / Limitations
  - Fixed profile doesn’t allow rock to move

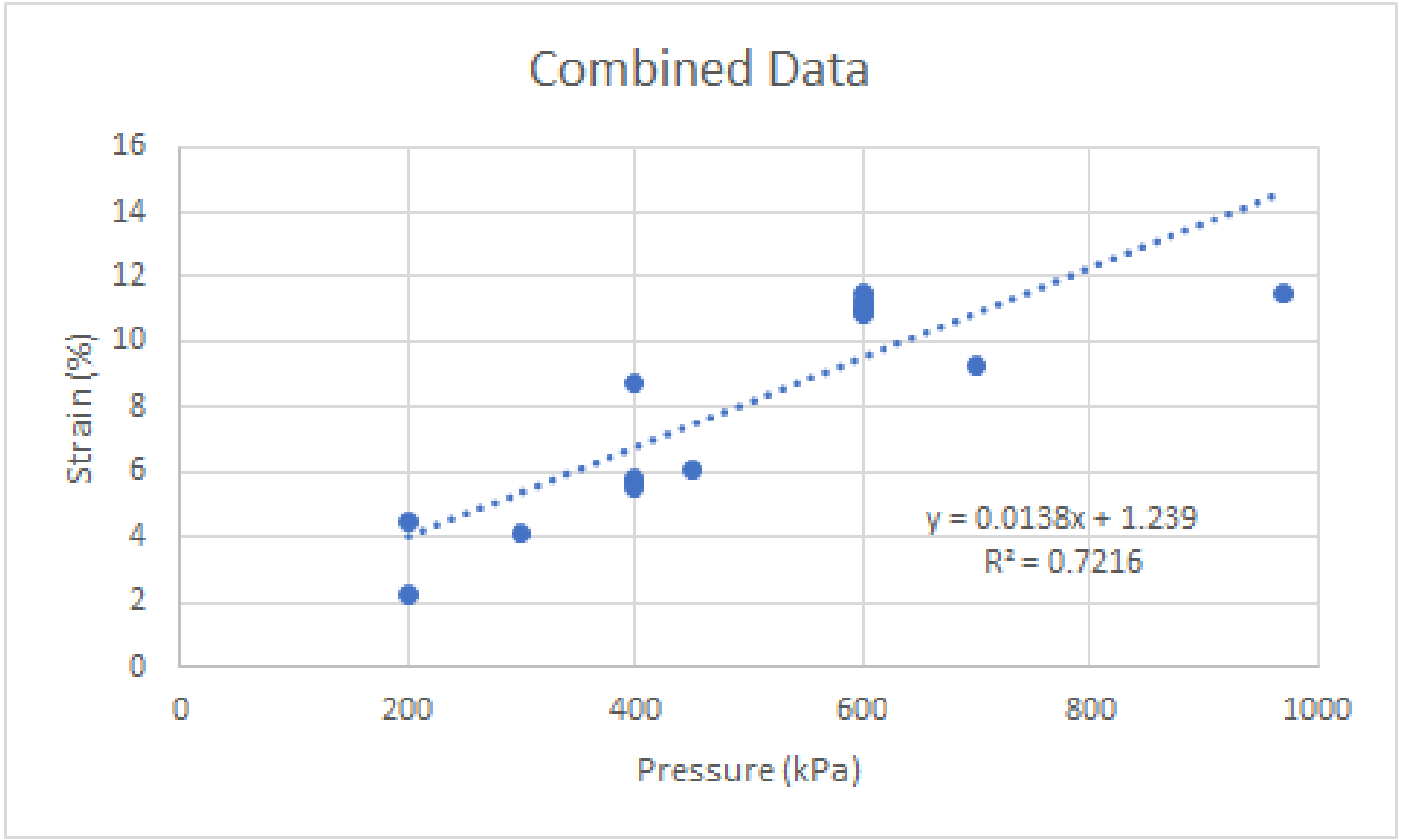
Australia - 20 to 50mm Aggregate





Load vs Strain Analysis

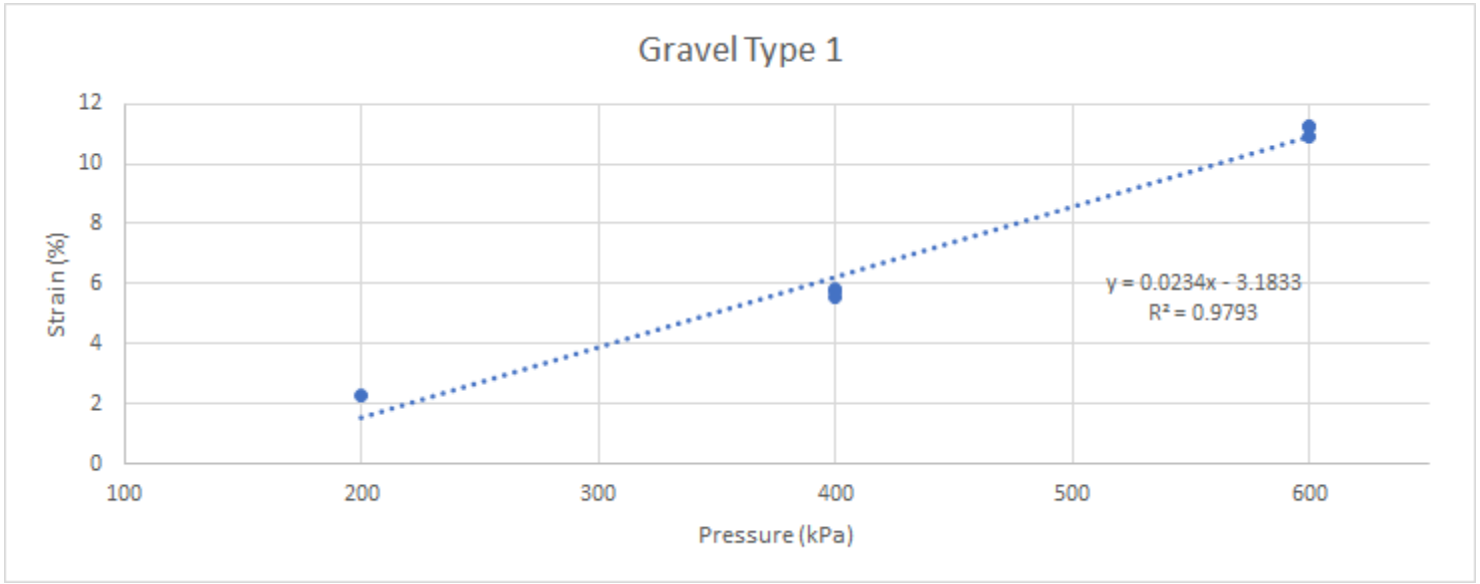
- Continuous Filament PET
- 350 to 950g/m^2
- 3 different rock profiles



Load vs Strain Analysis

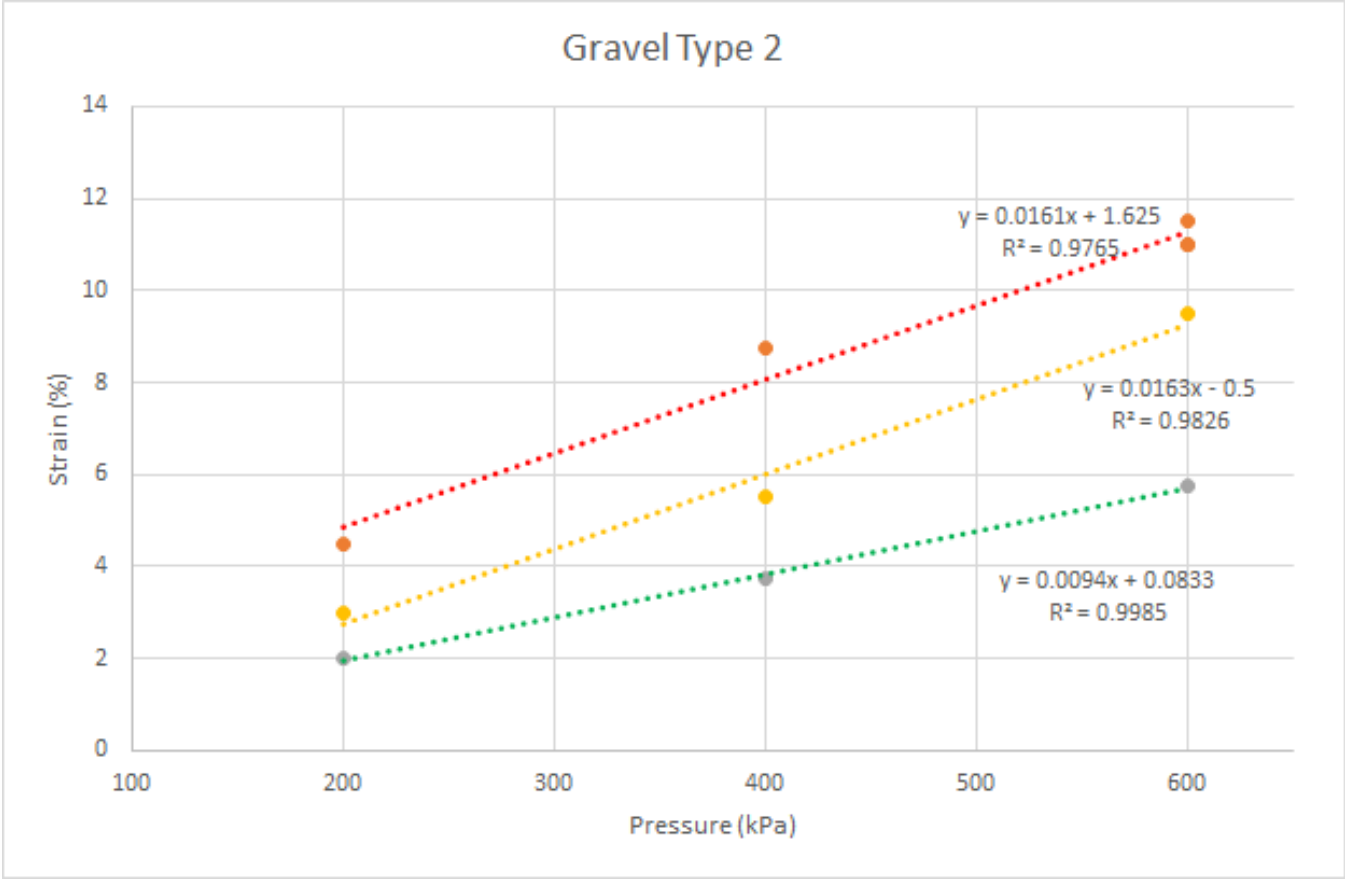
- Continuous Filament PET
- 350g/m^2

  - 200kPa – 1.49% Strain
    - 4.14 times
  - 400kPa – 6.17% strain
    - 2.5 times
  - 800kPa – 15.5% strain



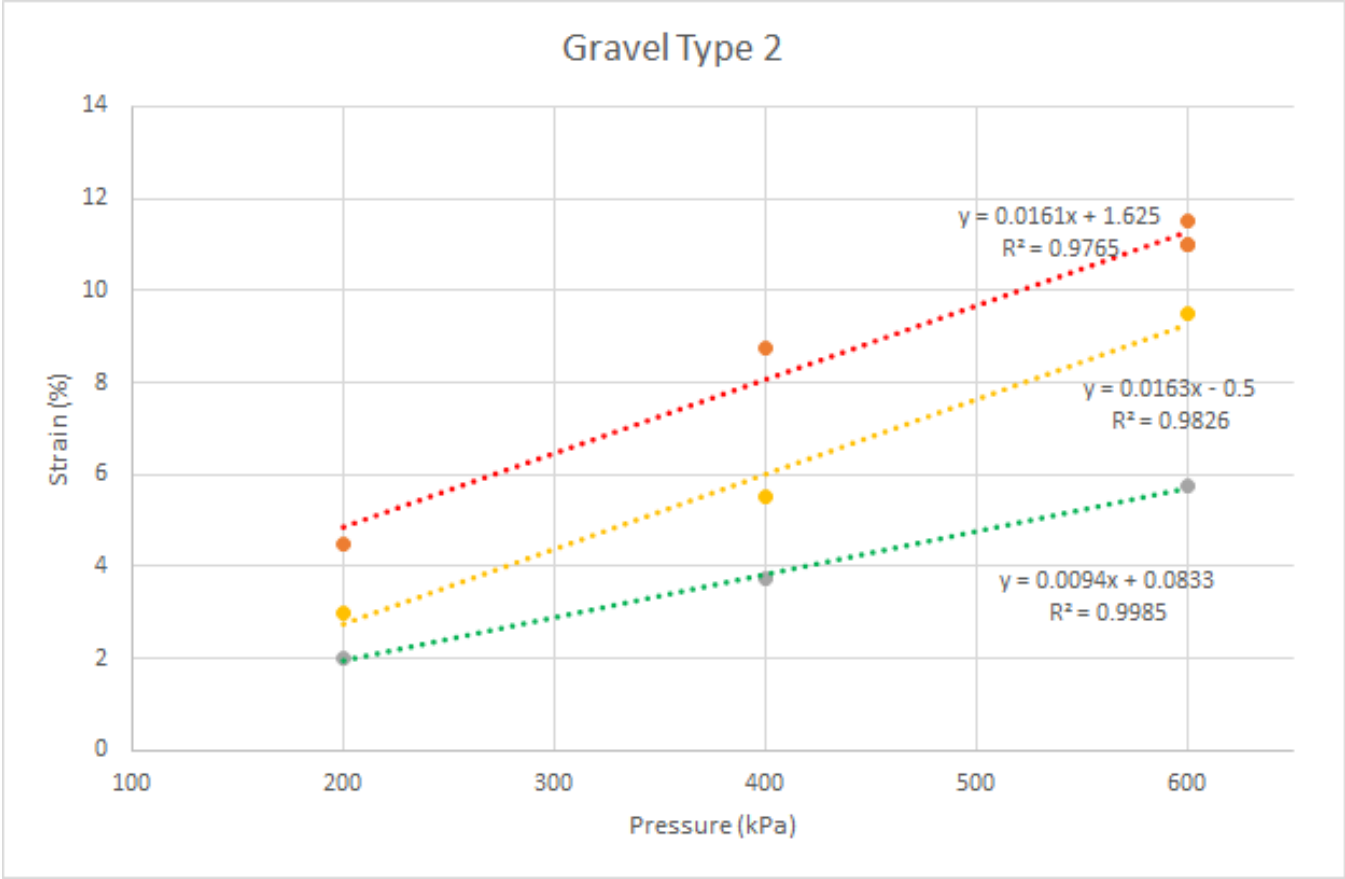
Load vs Strain Analysis

- Continuous Filament PET
- 350g/m^2
  - 200kPa – 4.8% Strain
    - 1.68 times
  - 400kPa – 8.1% strain
    - 1.79 times
  - 800kPa – 14.5% strain



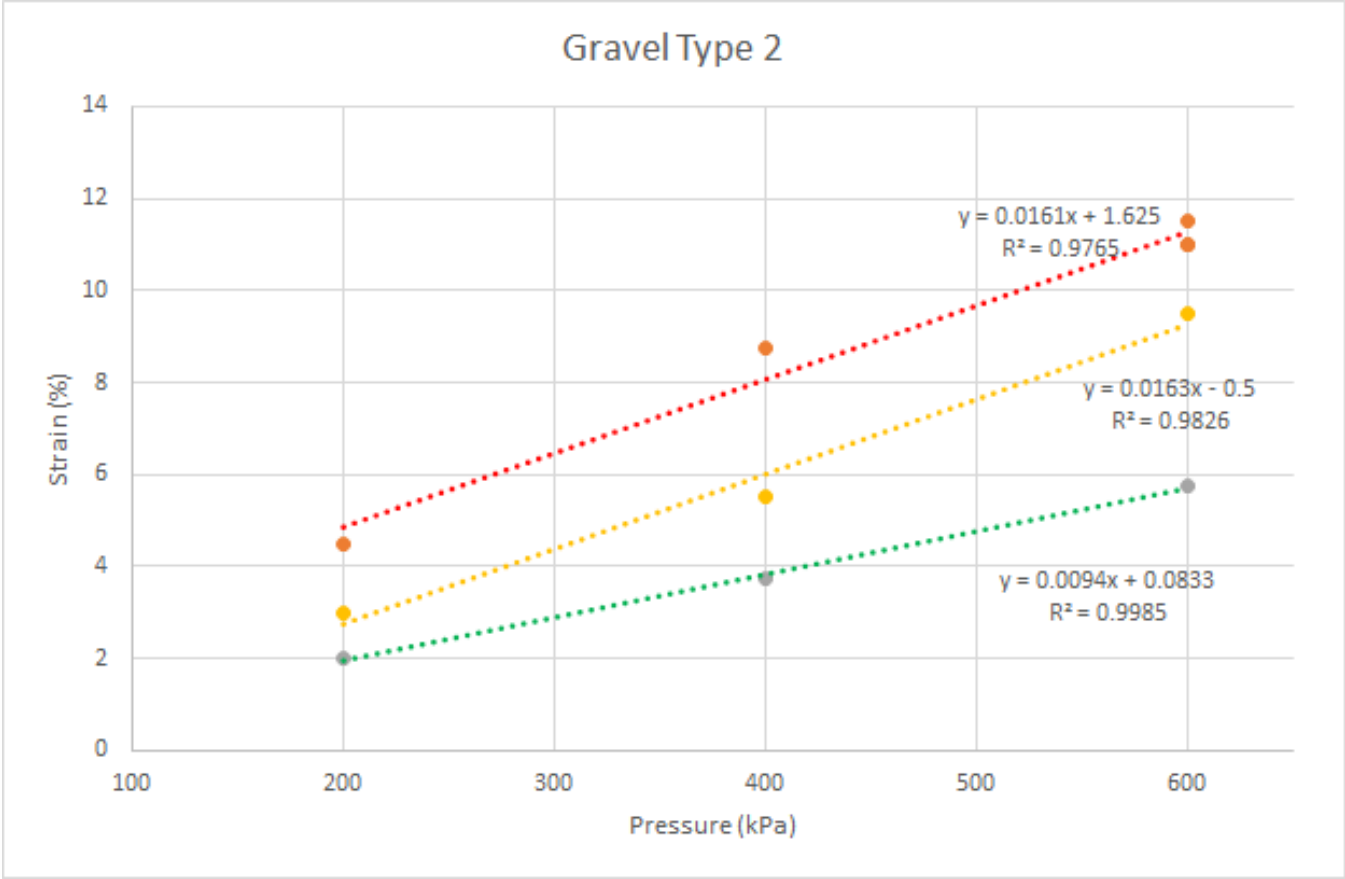
Load vs Strain Analysis

- Continuous Filament PET
- 500g/m^2
  - 200kPa – 2.8% Strain
    - 2.14 times
  - 400kPa – 6.0% strain
    - 2.08 times
  - 800kPa – 12.5% strain



Load vs Strain Analysis

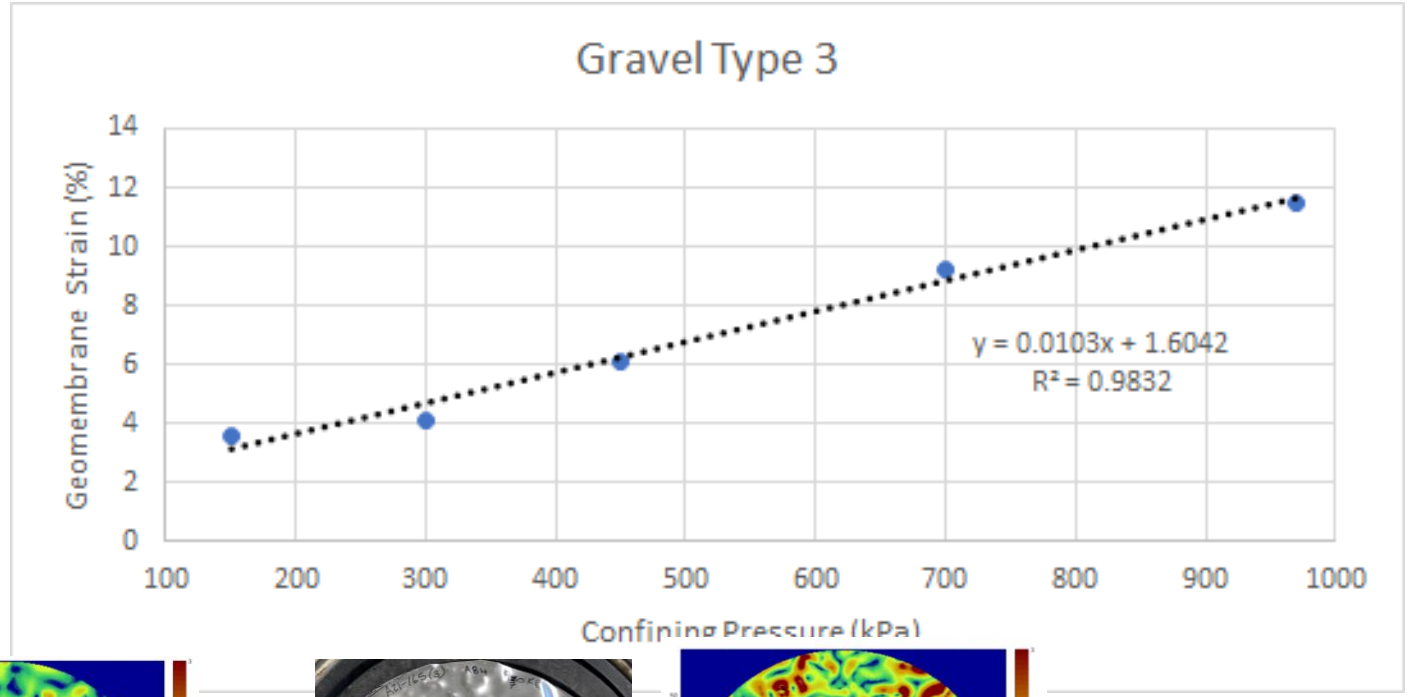
- Continuous Filament PET
- 950g/m^2
  - 200kPa – 1.9% Strain
    - 2 times
  - 400kPa – 3.8% strain
    - 1.97 times
  - 800kPa – 7.6% strain

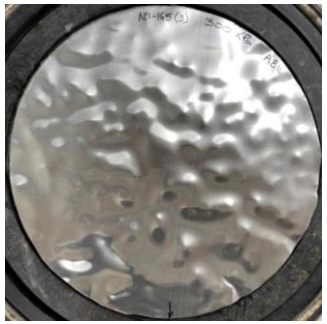


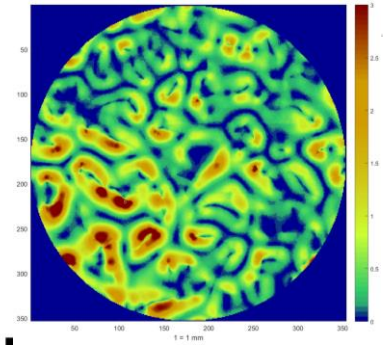
Load vs Strain Analysis

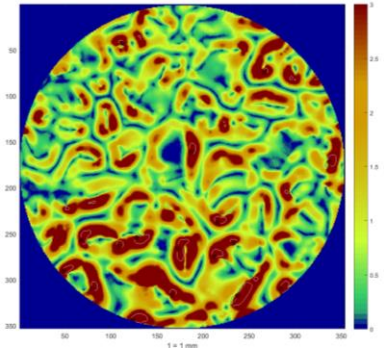
- Continuous Filament PET
- 780g/m^2

  - 200kPa – 3.6% Strain
    - 1.58 times
  - 400kPa – 5.7% strain
    - 1.71 times
  - 800kPa – 9.8% strain



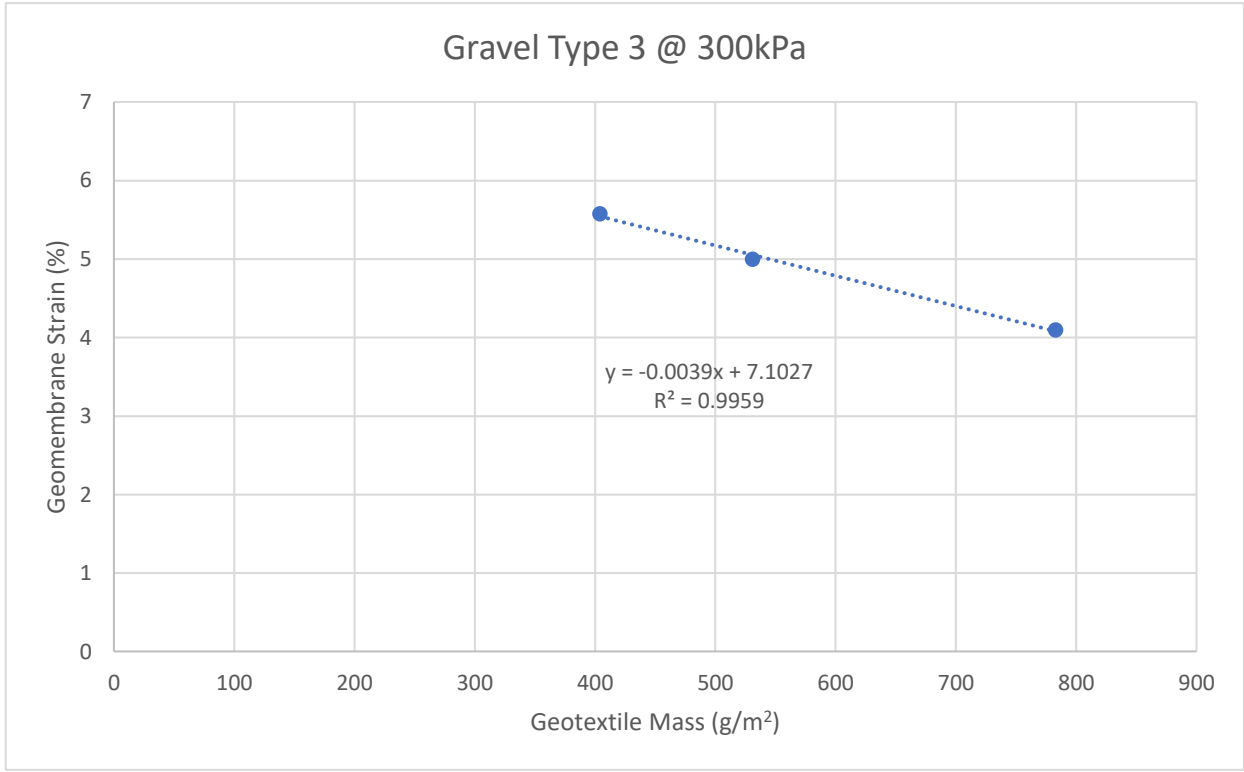






Strain vs Mass Analysis

- 300 kPa
- Continuous Filament ET
- 400 to 780g/m^2
  - 400 g/m^2 – 6.3% Strain
    - 1.15 times
  - 600 g/m^2 – 5.5% strain
    - 1.41 times
  - 800 g/m^2 – 3.9% strain



Profile Stability

* Profiles deteriorate over time

Conclusion

- There is no magic Number
- Strain values vary with gravel types
- The rough guide of double the load = double the strain is reasonable