Resilient Tracks on Trash: Polymers to Enhance Safety and Stability of Railways on Landfills

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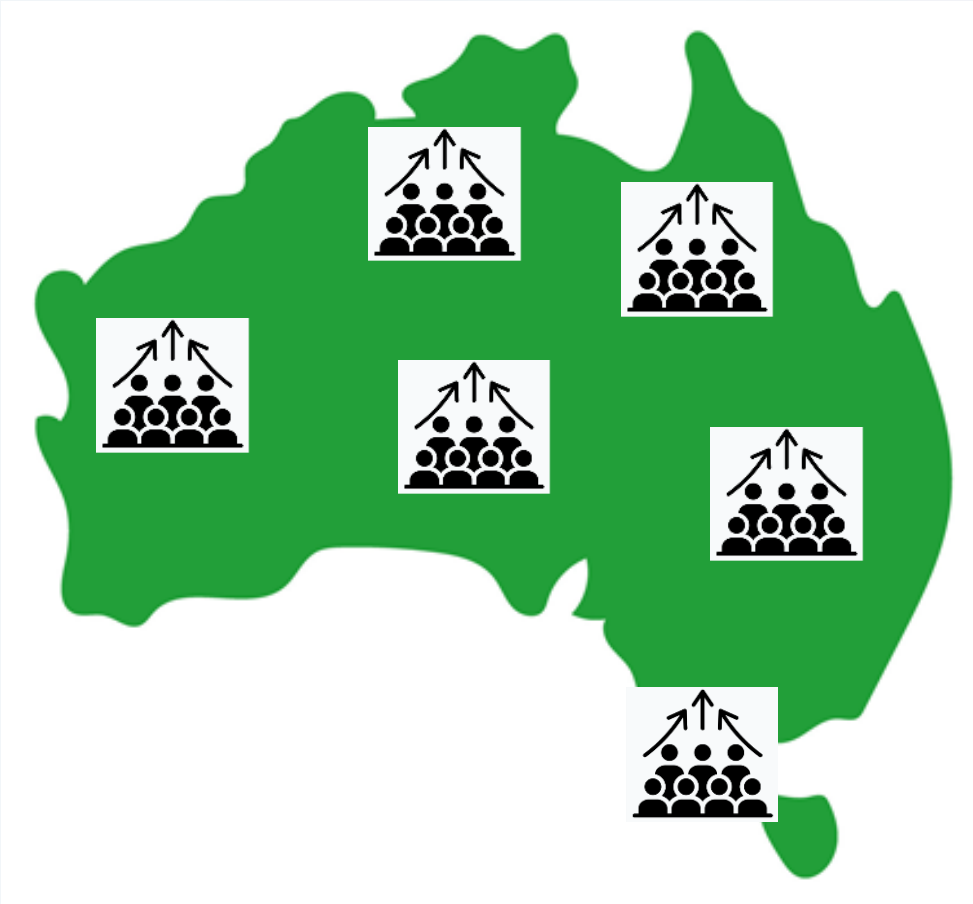
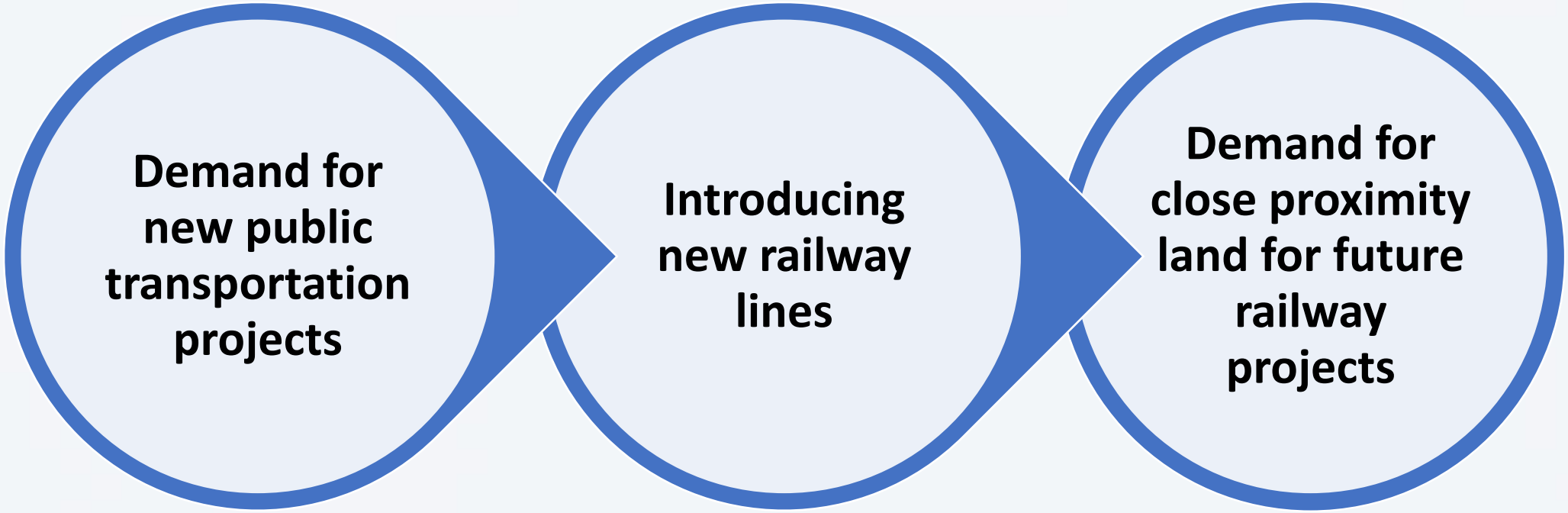
Do you know that..

By 2066, Australian population will be doubled!

- ✓ New structures and infrastructures projects
- ✓ Increase the demand for transportation
- ✓ Demand for land

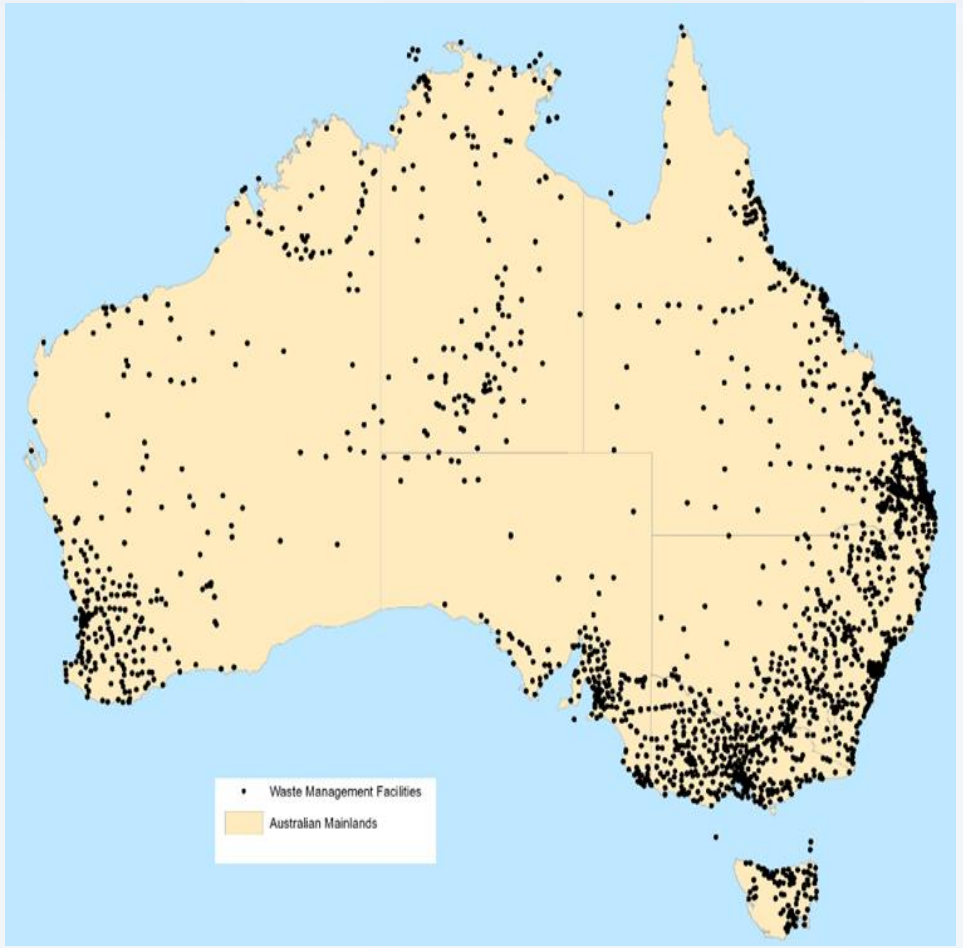


Background


Demand for new public transportation projects
Introducing new railway lines
Demand for close proximity land for future railway projects

Background

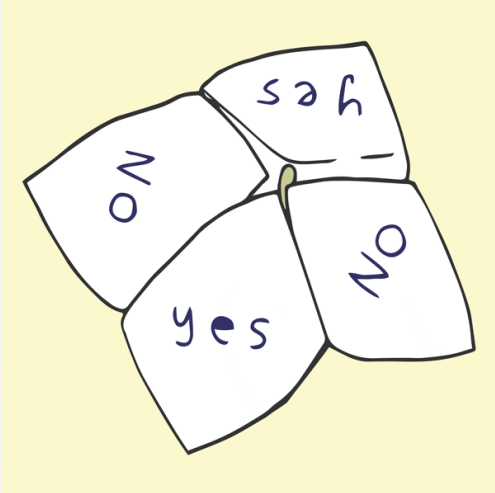
- Australia has 1168 landfill sites mostly clustered around major cities.
- Closed landfills will inevitably be located within close urban vicinities despite being originally constructed far from urban areas.
- The availability of space in urban areas is becoming scarce resulting in development above or adjacent to old landfills in urban areas

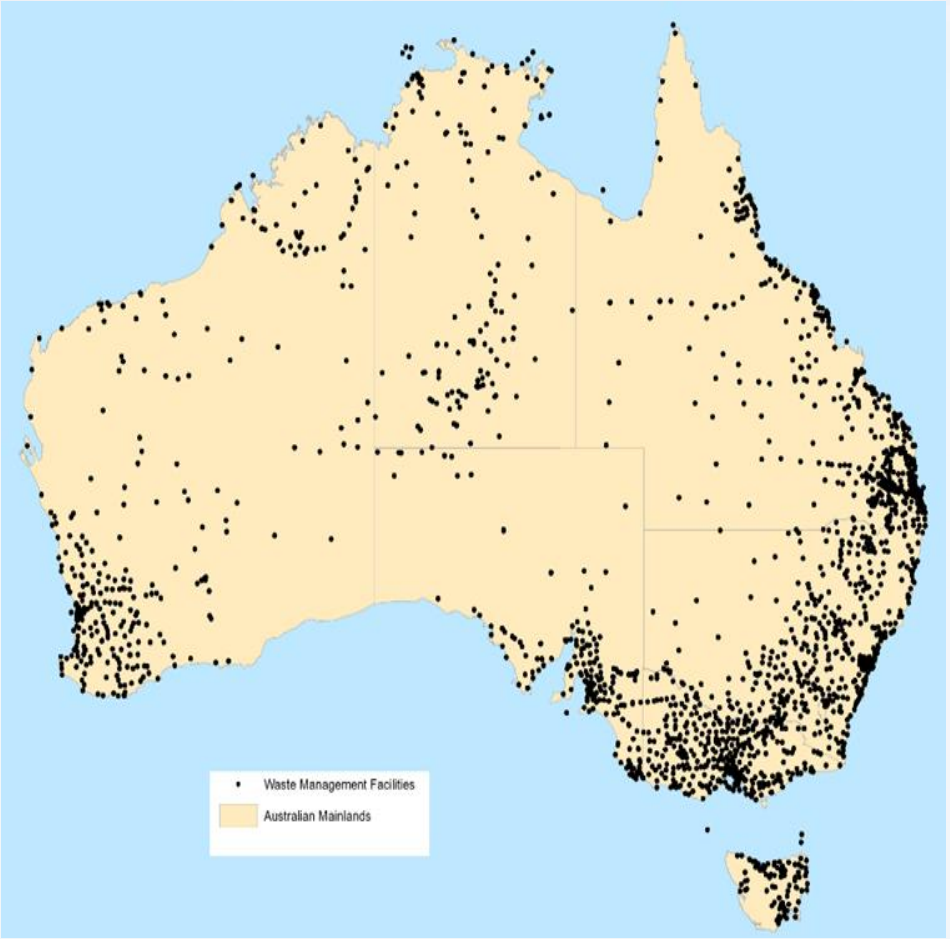


Landfill sites in Australia
(Geoscience Australia, 2017)

Background

Can we use closed landfill sites for new railway development?





Landfill sites in Australia
(Geoscience Australia, 2017)

Background

Moorebank Intermodal Project

South West Sydney CBD
Part of this project built on top of a landfill

Facilities:

- Operation Terminal, Import/Export Terminal, Interstate Terminal
- Warehouses
- Distribution Centres
- Offices
- Accommodation and business facilities

Moorebank Intermodal Precinct

Background

Reported settlement issues for projects built on landfills in NSW

Sinking Suburbs!

Good news for homeowners in sinking suburb

By A Current Affair Staff | 3 years ago

There has been some good news for homeowners in Jordan Springs East who could be in line to receive a slice of a staggering $600 million compensation offer from the developer of the sinking suburb.

A Current Affair recently covered a story about the entire suburb sinking and spoke to a number of devastated homeowners in the far western Sydney suburb at the time whose houses were cracked and damaged.

Some were even knocked down because the landfill they were built on wasn't sufficiently compacted.

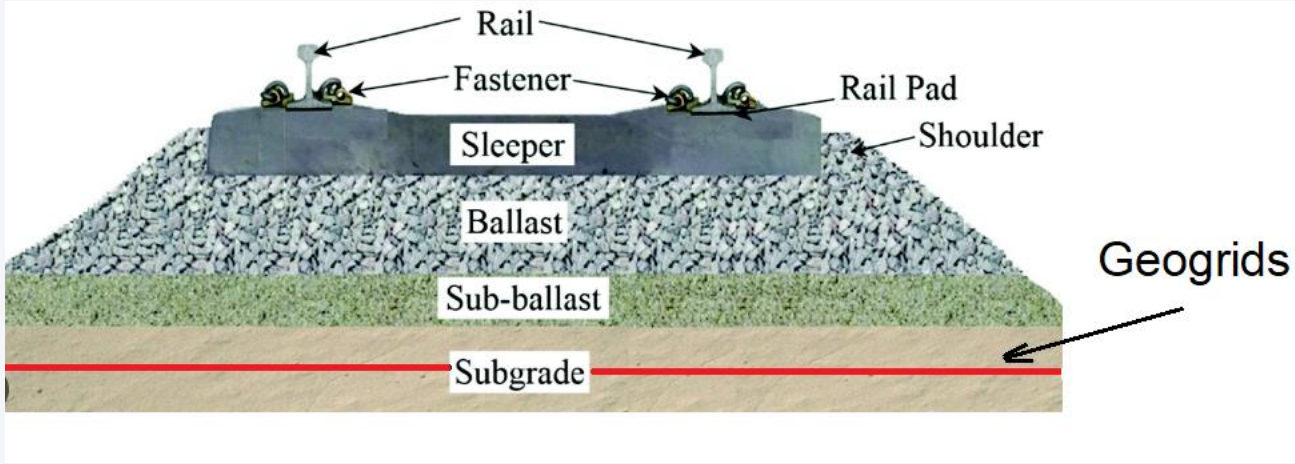
Statement of the problem

Waste settlement significantly impairs railway construction on top of closed landfills

Unsafe uncomfortable bumpy tracks

Solution

Reinforcing landfill subgrade of railways using reliable, efficient, and cost-effective polymeric geosynthetic



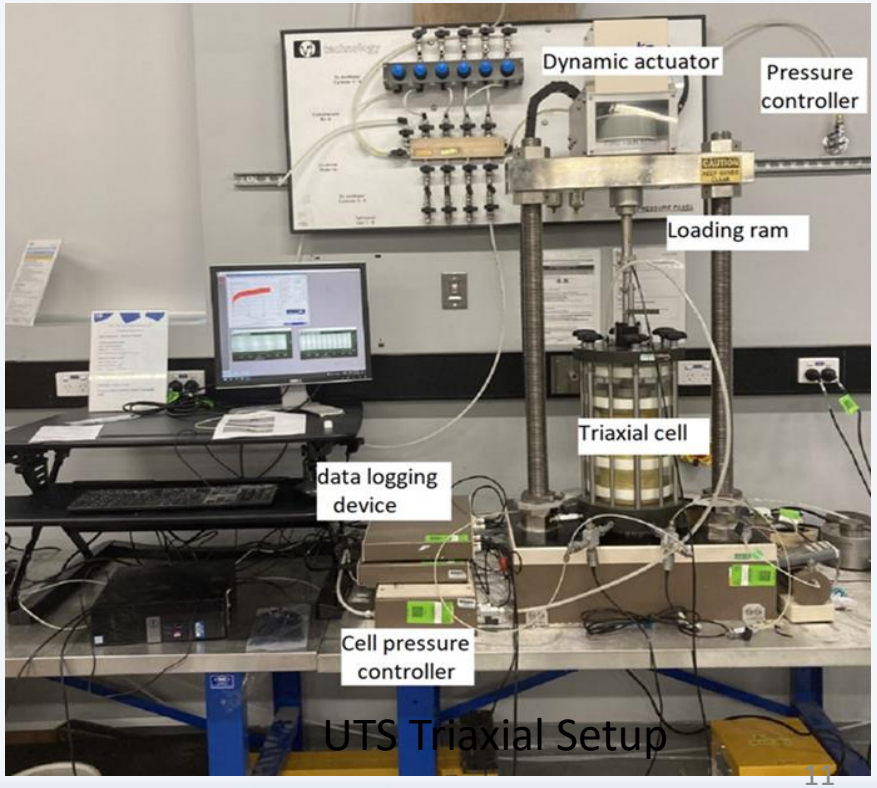
Cross-section of railway track

Aim and method

To investigate the stability of railways built on top of geosynthetics reinforced landfill subgrade

Landfill settlement due to cyclic loading

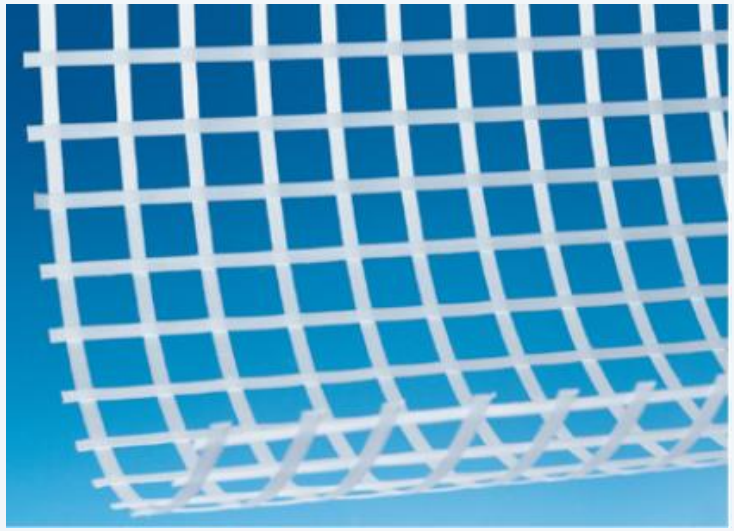
Laboratory testing program using unreinforced and geogrid-reinforced landfill samples



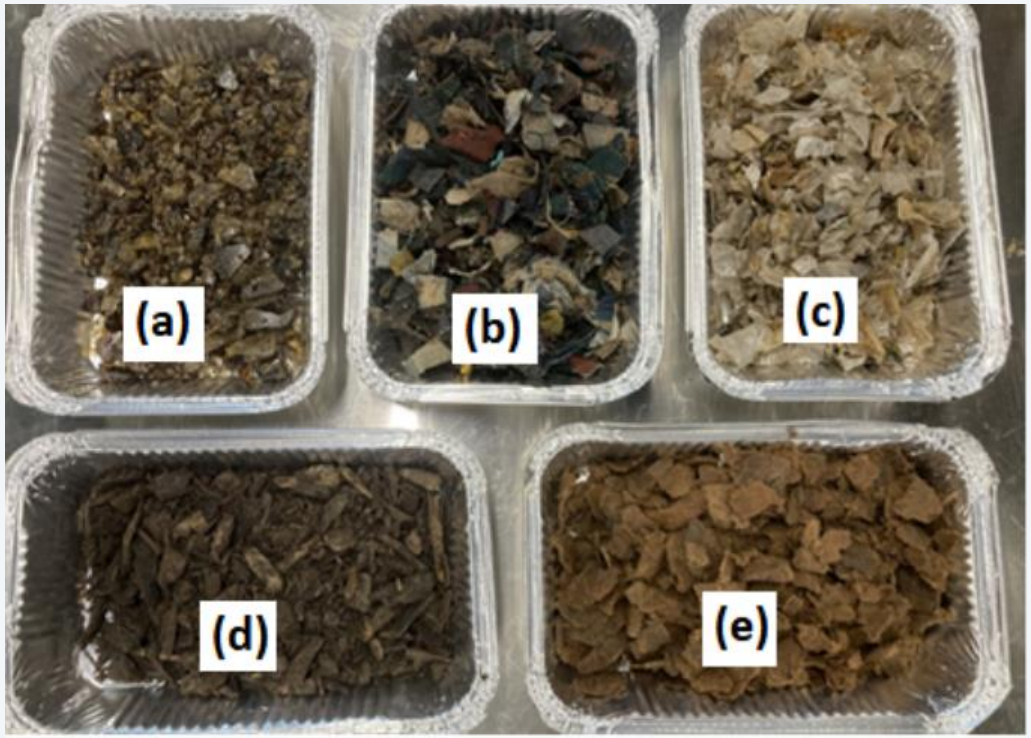
UTS Triaxial Setup

Experimental study

- High modulus biaxial polypropylene geogrid used
- Landfill material preparation (particle size < 16mm)



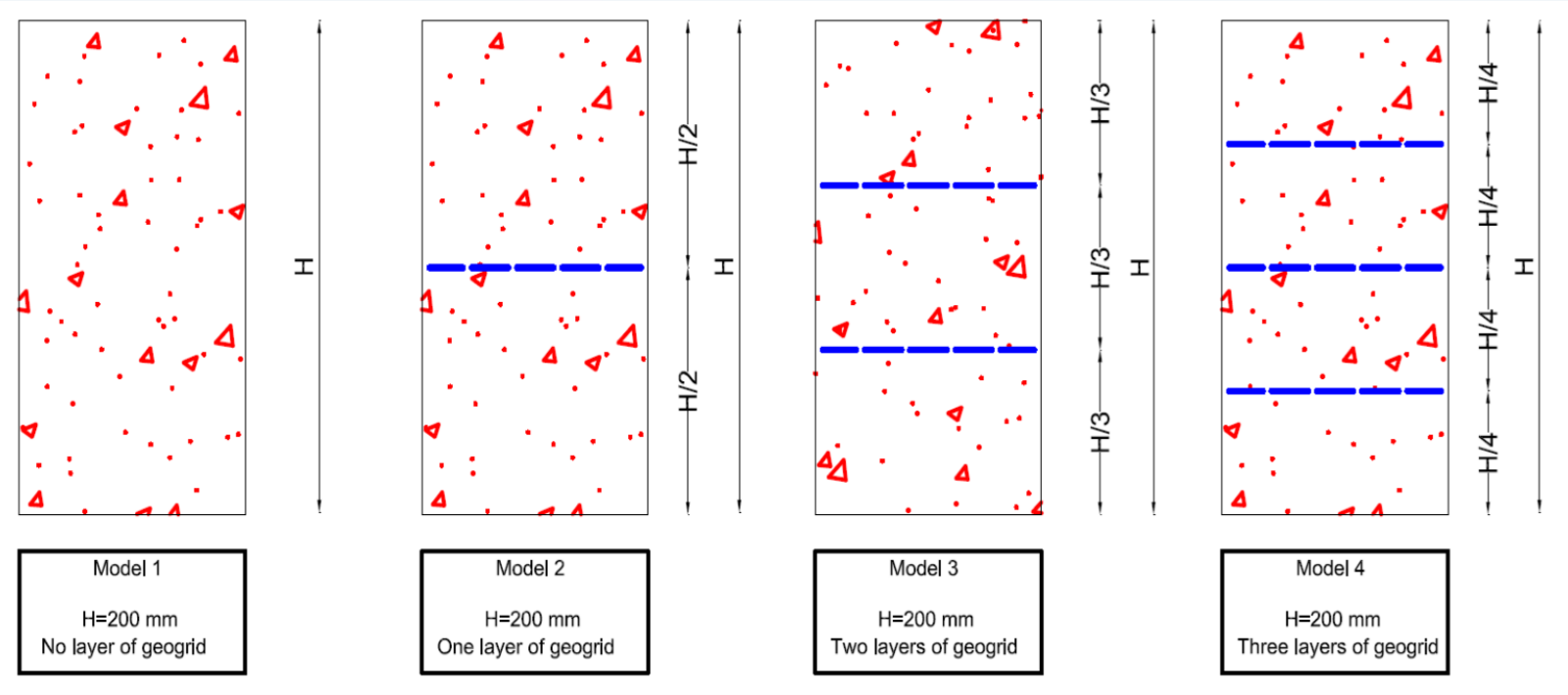
Biaxial Geogrids (strength 30/30 KN/m)



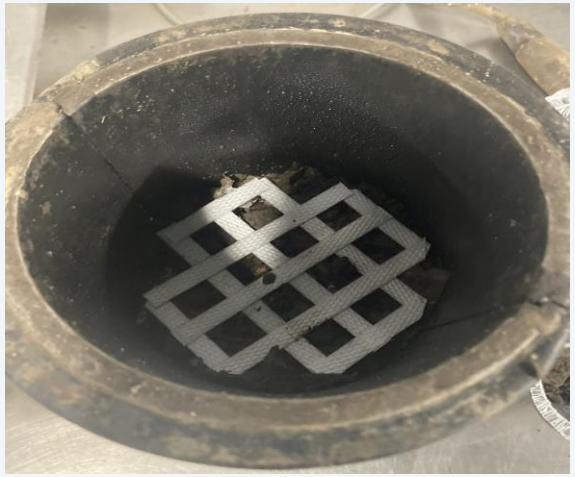
Landfill Material Preparations (a)Glass, (b)Clothes, (c)Plastics, (d)wood, and (e)Paper and cardboard

Experimental study

- Cyclic triaxial testing with a frequency of 2 Hz and up to 50000 cycles
- Three dynamic stresses tested (q^{cyclic}=25, 50, and 100 KPa)



Cyclic Triaxial Testing Models

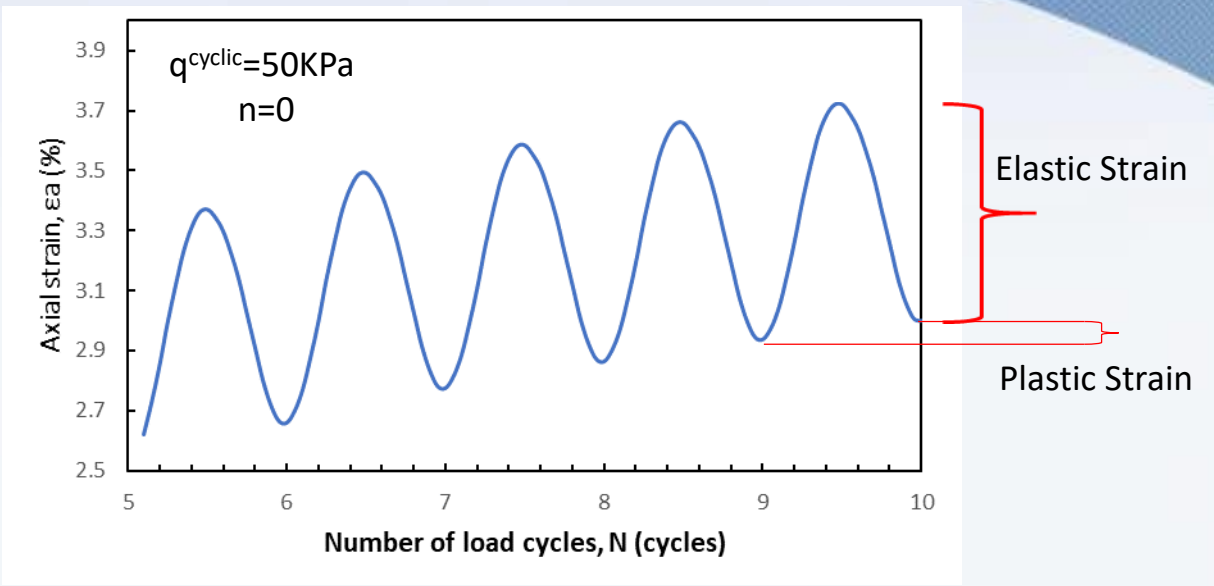


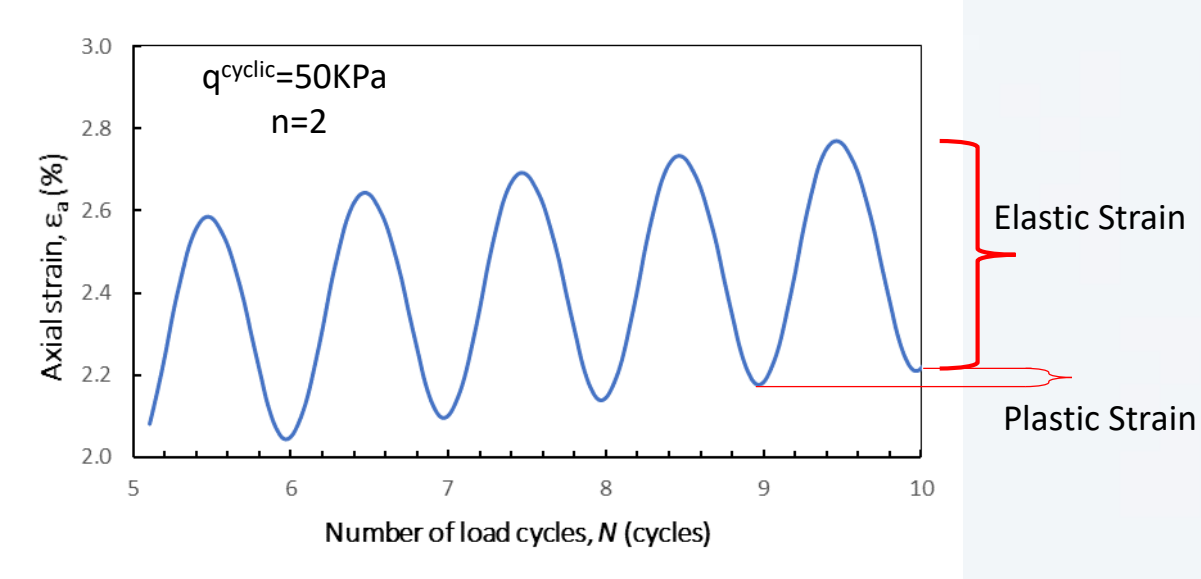
Triaxial Sample Preparation

Results

- After 10 loading cycles, both elastic and plastic strain reduced using 2 geogrid cycles
- Axial strain reduced with increasing the number of geogrids layers in the sample

No. of geogrid layers	0	1	2	3
Elastic strain (%)	0.721	0.603	0.557	0.413
Plastic strain (%)	0.062	0.049	0.034	0.017

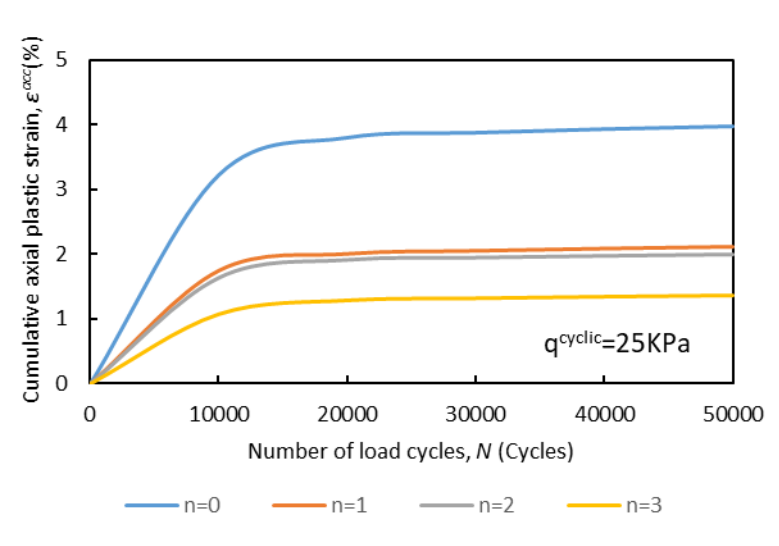


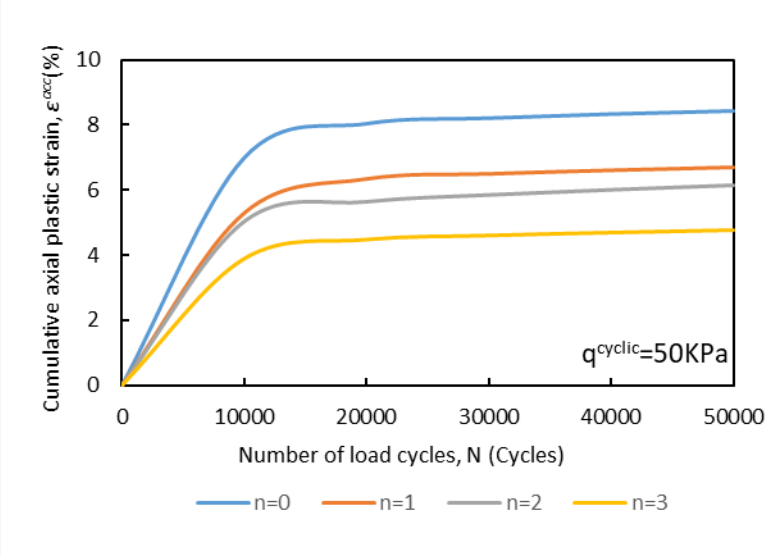


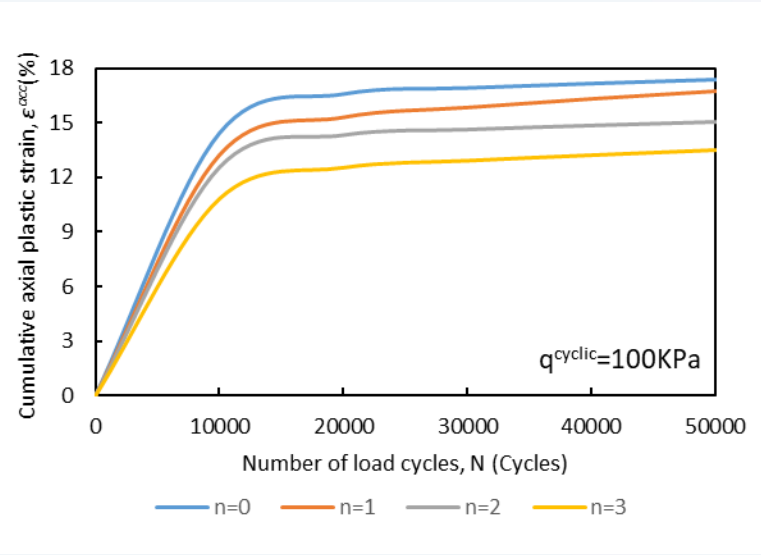
Elastic and plastic strain with different geogrid layers

Results

- Long-term settlement decreased with increasing the number of geogrid layers
- Settlement reduction rate is found to be affected by the cyclic stress. The rate improved when the specimen tested under higher q^{cyclic} value by up to 4%.







Plastic strain with different number of geogrids and cyclic deviator stresses

Summary and highlights

- The inclusion of geogrid within the subgrade layer of railway system built on top of landfill has a great potential to reduce settlement
- More geogrid inclusion showed better results regarding accumulated settlements which will help design and operate safe and comfortable railway lines
- Design engineers can use results from this study to assess railway short and long term settlement built on top of landfills.

References

- Geoscience Australia. (2017). waste management, recycling and reprocessing facilities in Australia. National Waste Management Facilities Database.

- Moorebank Intermodal Precinct. (2023). https://moorebankintermodalprecinct.com.au/

Acknowledgement

- Global Synthetics
- TechLab Team at UTS

Thank you