

Bauhaus Summer School: Forecast Engineering

Micro-reinforcement of coarse granular aggregates

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PhD Overview

Thesis Title: Nature inspired Micro-reinforcement of coarse granular aggregates

Timeline: first year of four

Supervisor: Prof. Margarida Lopes (University of Aveiro, Portugal)

Co-supervisor: Prof. William Powrie (University of Southampton, United Kingdom)

Current impact:

- Submitted a paper “Soil-Geosynthetic interaction under triaxial conditions influence of the specimen dimensions” for the Special Issue: Soil-Geosynthetic interaction of the International Journal of Geosynthetics and Ground Engineering.
- Preparing a paper “Railway Ballast Track: traditional and reinforced solutions” based on the state of art of my PhD
- Submitted abstract “Reinforcement of coarse granular aggregates with micro-grids: Influence on packing” for the XVIII European Conference on Soil Mechanics and Geotechnical Engineering (Lisbon – 2024, Portugal)
- Submitted abstract “Effect of crumb rubber size on the mechanical response of scaled ballast: Monotonic triaxial tests for the 5th International Conference on Transportation Geotechnics (Sydney – 2024, Australia)

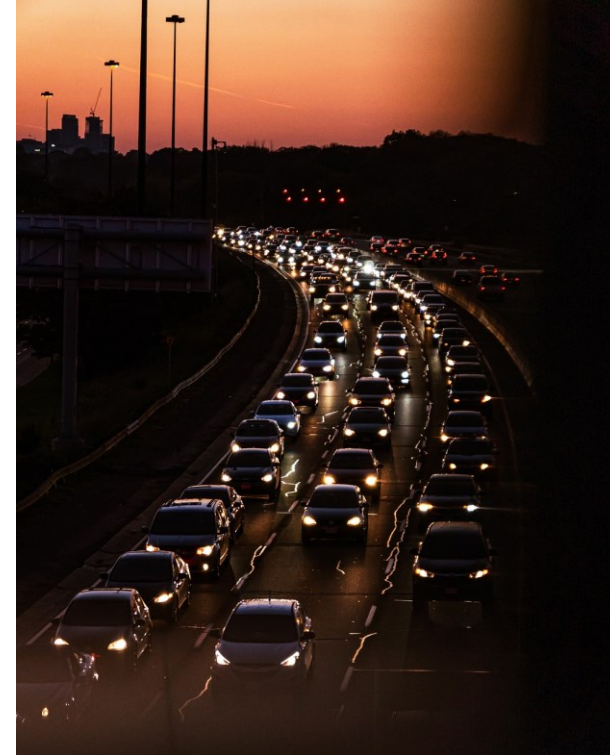
Introduction

- Since the beginning of the 21st century, environmental concerns have increased.
- In Europe, transportation sector is responsible for 25.8% of the Green House Gases emissions [1].
- Road transport is responsible for 71.1% of these emission while railway only produce 0.4% [1].



European Union plans to:

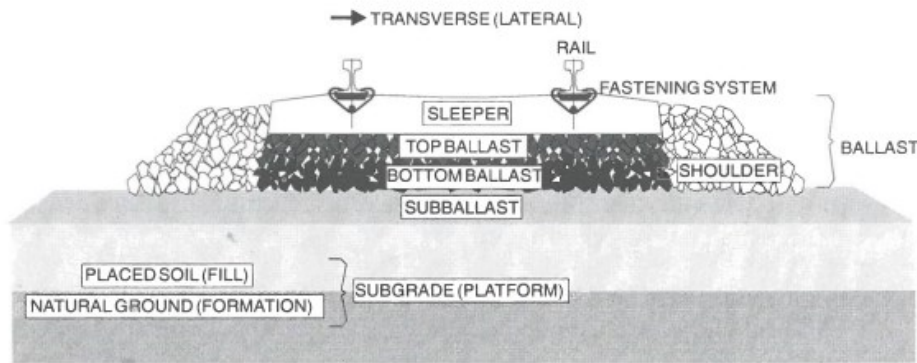
- Construct more railway lines (*Ten-T*) and electrify the existing ones;
- Increase the number of passengers and freight transported by rail;
- Reducing air and road transport.





Railway track

Ballast track



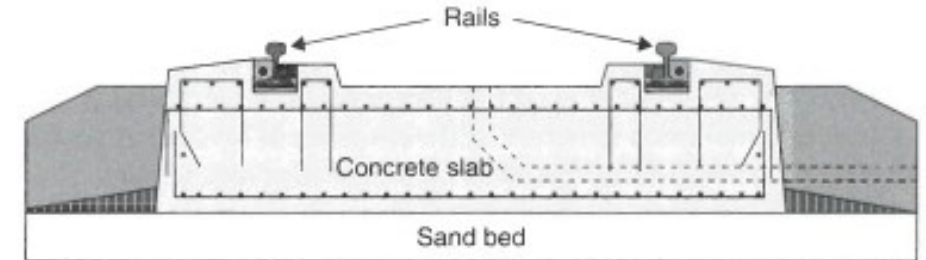
Pro:

- Reduced loss of geometry;
- Reduce up-front cost;
- Well established design rules;
- High permeability.

Cons:

- High maintenance costs;
- Lower lateral resistance.

Slab track



Pro:

- Reduced maintenance costs;
- High lateral resistance.

Cons:

- High up-front costs;
- Poor elasticity;
- High induced ground vibrations;
- Excellent construction control.



Ballast

- Quarried;
- Angular;
- Uniformly graded;
- $15 < D_{\text{particle}} < 50$ (mm);

Standards:

- EN 13450 (Aggregates for Railway Ballast).

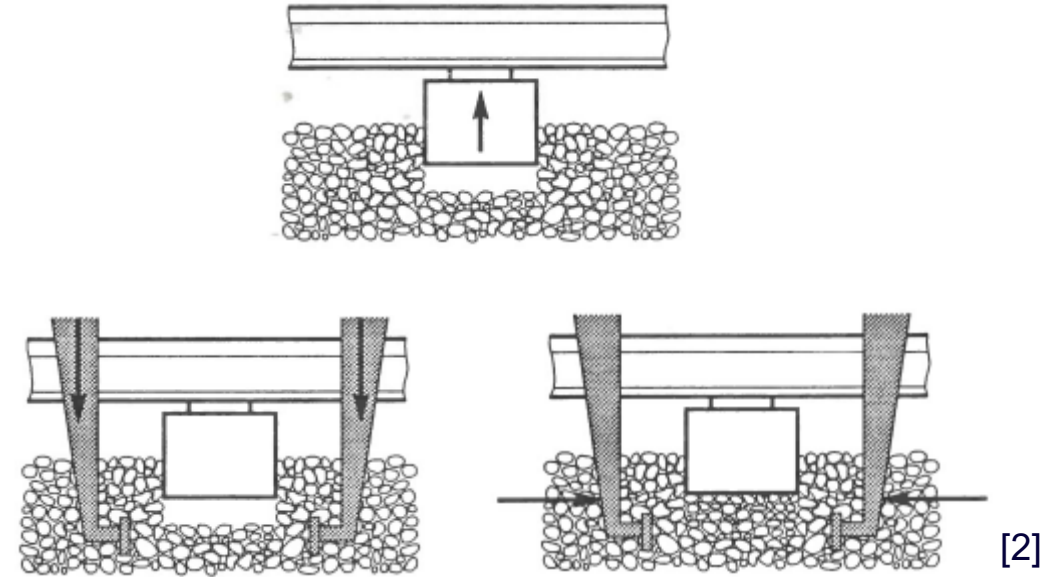


Ballast

- Under dynamic load ballast becomes fouled;
- Ballast particle breakage;
- Fine contamination.



[3]



- To restore initial ballast properties maintenance is required

Emerging and Novel techniques for ballast

Ballast Improvement



[4]

Polyurethane



[5]

Bitumen

Ballast reinforcement



[6]

Geosynthetics



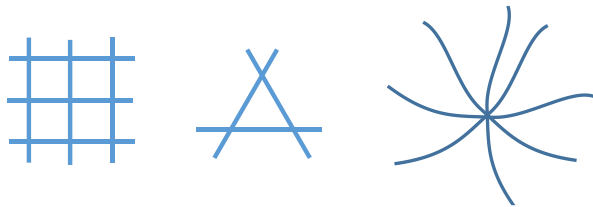
Tyre derived aggregate^[7]



[8] Synthetic fibres

Emerging and Novel techniques for ballast

- Triaxial tests (monotonic and dynamic);
- Permeability tests;
- Packing tests;
- Real scale ballast test.



[9]



[9]



Acknowledgements

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