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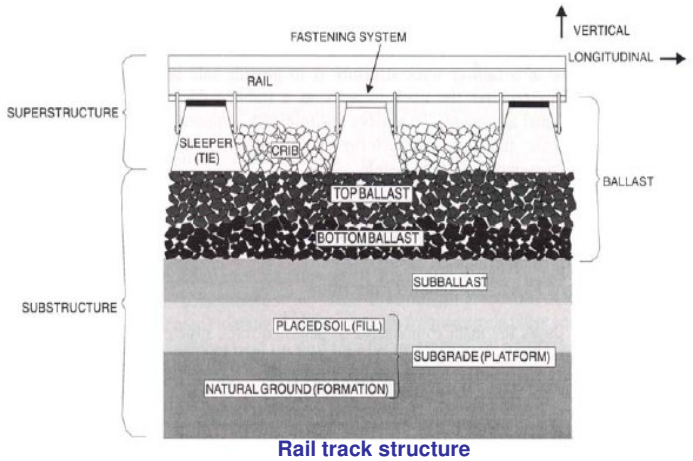
Design and construction of a new full-scale cyclic Geopavement & Railway Accelerated Fatigue Testing facility

Justin Kennedy, 3rd year PhD Civil Engineering, School of the Built Environment, Heriot Watt University. PhD supervisor: Dr. Peter Woodward

Overview and aims of research

Railway track settlement and pavement deterioration are serious problems in modern day road and rail engineering and have considerable cost and time implications to their industries through maintenance operations, reconstructions and speed restrictions. As a result, several geosynthetic products have been developed over the last decade to resist the various causes of railway track settlement and pavement deterioration, including railway ballast deterioration and subgrade pumping. However, there is a severe lack of full scale laboratory testing facilities that can simulate the harsh environment beneath a real rail track or pavement. Thus, this research has designed and constructed the cyclic GRAFT (Geopavement & Railway Accelerated Fatigue Testing) facility at Heriot-Watt University. The facility is in the final stages of construction and once complete it is envisaged that many geopavement and railway products will be rigorously tested within the facility. The facility will firstly be used as a railway track testing facility and the track has been constructed to simulate a railway track structure similar to that shown below.

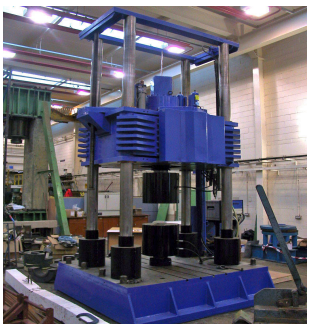


Rail track structure

The cyclic GRAFT facility

The new cyclic GRAFT (Geopavement & Railway Accelerated Fatigue Testing) facility at Heriot-Watt University consists of a full geopavement or railway trackbed constructed within a steel box 1.06m x 3.0m x 1.15m high. Once prepared the box is lowered into a cyclic hydraulic loading rig that is capable of applying load up to 200 Tonnes.

Steel box to hold trackbed



Cyclic loading rig

The railway trackbed currently under construction within the box consists of a 0.85m deep clay subgrade layer overlain by a 0.3m deep layer of railway ballast. The compacted clay subgrade is shown below. On top of the ballast layer 5 sleeper sections are placed within crib ballast and a rail section is placed on top.

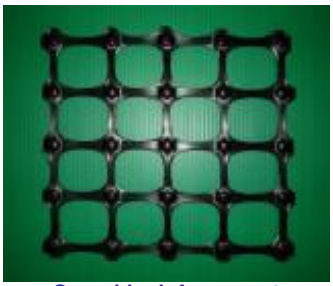
Clay subgrade within tank

Box positioned under actuator

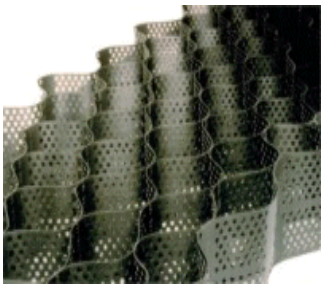
The centre sleeper is cyclically loaded to 12.5 Tonnes, via the rail section, at a frequency of 4Hz. This loading generates realistic stress levels in the ballast and subgrade layers and simulates a single wheel load of a train travelling over the centre sleeper at 23mph. In total, applying 800,000 cycles (56 hours) is approximately equivalent to one years train traffic on a main line.

Future research using GRAFT facility

Different forms of geosynthetic reinforcement, including geogrid and geocell reinforcement, will firstly be investigated in the GRAFT facility.



Geogrid reinforcement



Geocell reinforcement

These well established polymer reinforcement techniques can be used to improve the mechanical properties of granular track layers to increase their resistance to deformation. However, there is limited guidance of the quantifiable benefits of using such techniques. The future research intends to study several of these polymer reinforcements within the GRAFT facility. Track settlement and ballast layer stress levels will be monitored through load cells placed within the substructure and LVDT's placed on the middle sleeper. Thus, the results will quantify the benefits of the stabilisation in terms of reducing track settlement, ballast layer stresses, ballast particle breakage, depth of required granular layer and frequency of required maintenance, resulting in significant cost savings to the rail network in the long term. The results will be verified by finite element modelling of the test track conditions, which can be directly related to free field conditions.