GEOLAB

Transnational Access User Project

HSRTSUB: Resilient behaviour of stabilized and conventional high-speed's rail track subgrades under different drainage conditions and seat loads

HSRTSUB investigates deformation characteristics of clean and fouled ballast with an aim to assess the affect of fouling upon the deformation properties of ballast
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ZAG/UM Large-scale Triaxial Apparatus

Ljubljana, Slovenia 01-02-2023 to 17-02-2023

Organization	Country	Industry	Total No. Users	M/F Ratio	SME
Afyon Kocatepe University, Faculty of Engineering, Department of Civil Engineering Afyon Kocatepe Üniversitesi, Ahmet Necdet Sezer Campus Gazligöl Road, 03200, Afyonkarahisar	Turkey	Academia	2	2/0	N

DESCRIPTION OF THE EXPERIMENTS

In this study, the shear strength of track ballast material is evaluated by testing different types of track ballast specimens, which was conducted in a Large-scale Triaxial Apparatus at ZAG) that has a shear area of 40 x 40 cm and can accommodate specimens up to 80 cm high. It enable loading of specimens in simple shear mode.

The tests, which were conducted within HSRTSUB project, include two different types of ballast, the fouled ballast samples and the clean ballast samples, and two different specimen preparation techniques (with and without compaction). The normal stresses used cover a wide range from 50 to 400 kPa.

The European standard EN13450 "Aggregates for railway ballast" was used. This standard specifies the properties of aggregates obtained by processing natural, manufactured or recycled crushed unbound aggregates for use in the construction of the upper layer of railway track. For the purposes of this standard, the aggregate is referred to as track ballast.

Tests were conducted under unsaturated conditions with two types of lightweight materials:

- fouled ballast aggregates and
- clean ballast aggregates

Testing material

Reconstruction of old railroad tracks involves removal of ballast, which is considered waste. Large quantities of excavated material can be usefully used for track substructure.

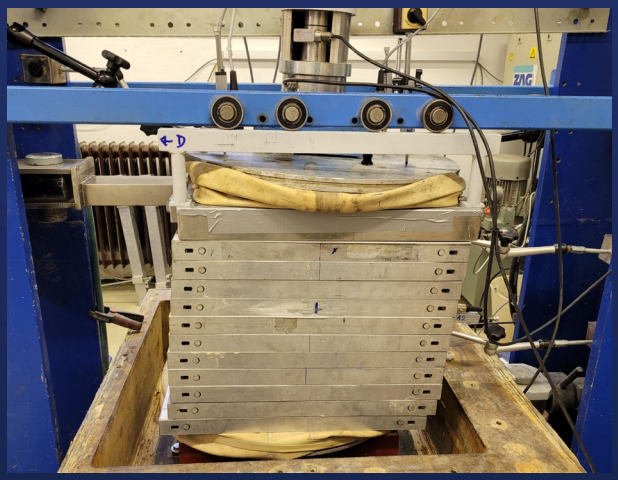
Railway track ballast is a frost-resistant and water-resistant stone material with angular grains of different sizes, where the grain size can be the same as when taken from old railway track, or can be defined by cleaning methods. It has a volume weight ranging from 1446 kg/m3 to 1696 kg/m3, depending mainly on the cleaning and the impact method. Samples of fouled and clean ballast were prepared at relative densities equal to approximately D_r=0.65.

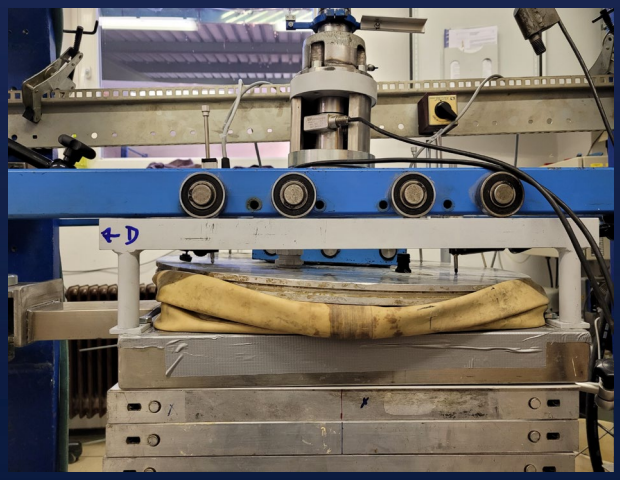
INNOVATIVE ASPECTS

The resilience of a railway track refers to its ability to absorb and dissipate the dynamic loads generated by passing trains, and to return to its original shape and position after deformation. The resilience of a railway track depends on several factors, including the design and construction of the track, the type and condition of the rail and ballast, and the properties of the underlying soil or rock.

Principal stress rotation refers to the change in the orientation of the principal stresses in the track structure due to changes in the direction and magnitude of the applied loads. This can occur when the track is subjected to lateral or longitudinal forces, or when the track is curved. At laboratory level, rotation of principal stresses can be achieved by loading of specimen in simple shear mode. Principal stresses are the maximum and minimum normal stresses that occur in a given stress state, and they are oriented along the principal axes of the stress tensor. When a material is subjected to a simple shear loading, the shear stress is applied along one principal axis while the normal stresses are zero, causing the principal axes to rotate.

In a simple shear loading, the direction of the maximum shear stress rotates with respect to the original coordinate system. This rotation can cause the principal stresses to rotate, but the magnitude of the principal stresses remains constant. Therefore, if the material is initially in a stress state where the principal stresses are not aligned with the coordinate axes, loading in simple shear mode can cause the principal stresses to rotate to some extent.





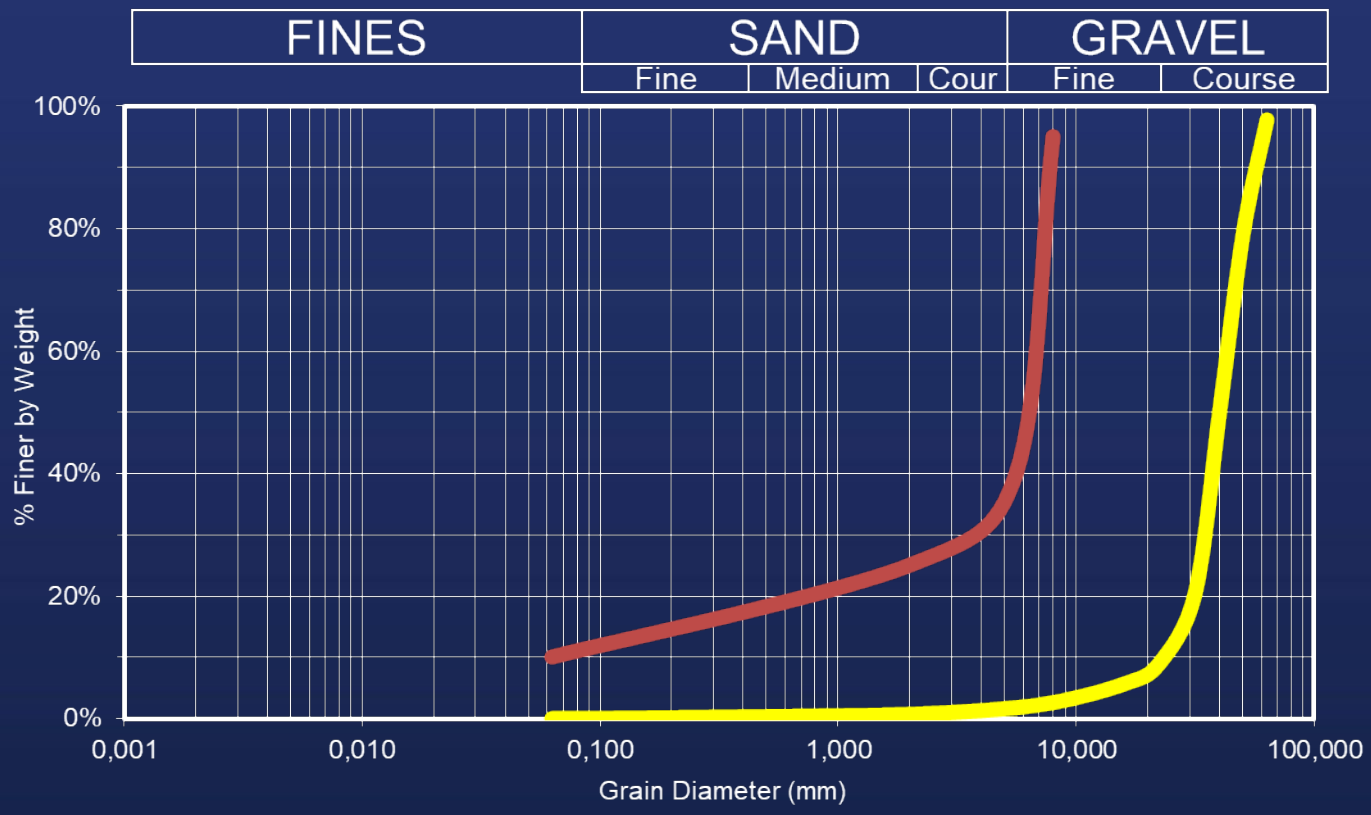
MAIN RESULTS

A series of simple shear tests were conducted with different proportion of fouling to assess the deformation properties of the track and the affect of fouling upon it. The main aim of the research has been to establish the relationship between the extent of fouling and the associated strength-deformation properties.

EXPECTED IMPACT

Rail ballast can become contaminated or fouled over time due to various factors such as grains breakage and the infiltration of subgrade fines during railway track operation. This process can lead to a decrease in track deformation characteristics such as stiffness and an increase in resilient and permanent deformation.

Therefore, it is crucial to regularly test and maintain railway tracks to prevent any potential safety hazards caused by the deterioration of the ballast. Through proper testing and maintenance, rail operators can ensure that their tracks remain safe and reliable for years to come.



Grain size analysis for clean and fouled ballast sample

CONCLUSION

To effectively address the issue of ballasted railway track degradation, large-scale laboratory tests, such as large-scale simple shear tests, are essential. These tests provide a detailed evaluation of the track's characteristics, allowing for proper maintenance activities to be carried out, which in turn ensures safe driving conditions on older railway tracks.

The HSRTSUB project is a prime example of the importance of such tests. Through a series of monotonic and cyclic simple shear tests on both clean and fouled ballast, the project highlighted the effects of ballast fouling and grain breakage on the safe use of old ballast tracks and their maintenance needs.

By utilizing the information and findings from large-scale laboratory tests such as these, rail operators can make informed decisions about the maintenance and upkeep of their tracks, ultimately ensuring the continued safety and reliability of their railway systems.