Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

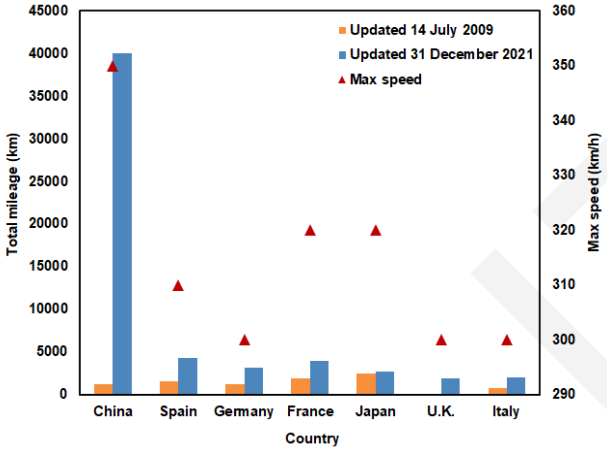
Impact of extreme climate and train traffic loads on the performance of high-speed railway geotechnical infrastructures

Ying WU, Haoran FU, Xuecheng BIAN, Yunmin CHEN

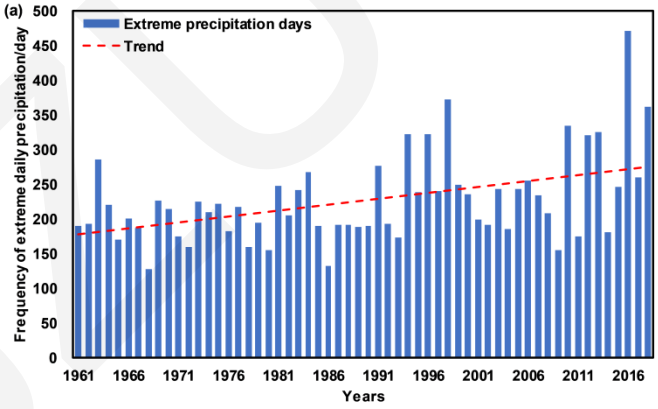
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https://doi.org/10.1631/jzus.A2200341

Introduction

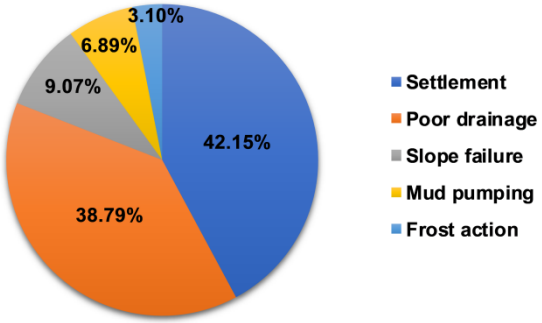
- High-speed railways have rapidly developed globally.
- Global warming increases precipitation and extreme climate events.
- Subgrade problems directly induce railway accidents.



Total mileage of high-speed railways in the world



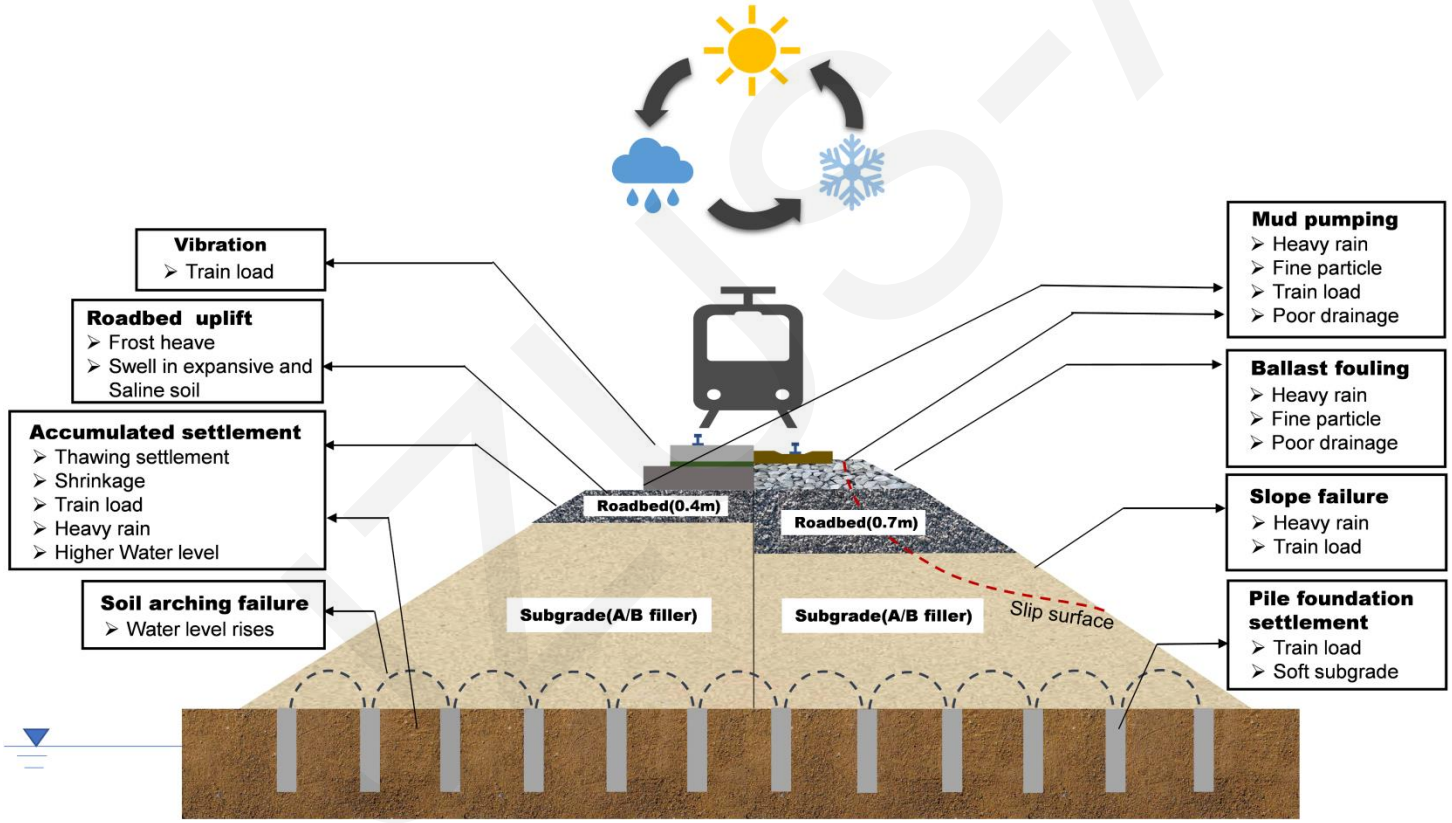
The Frequency of extreme daily precipitation in China



Railway subgrade problems in China

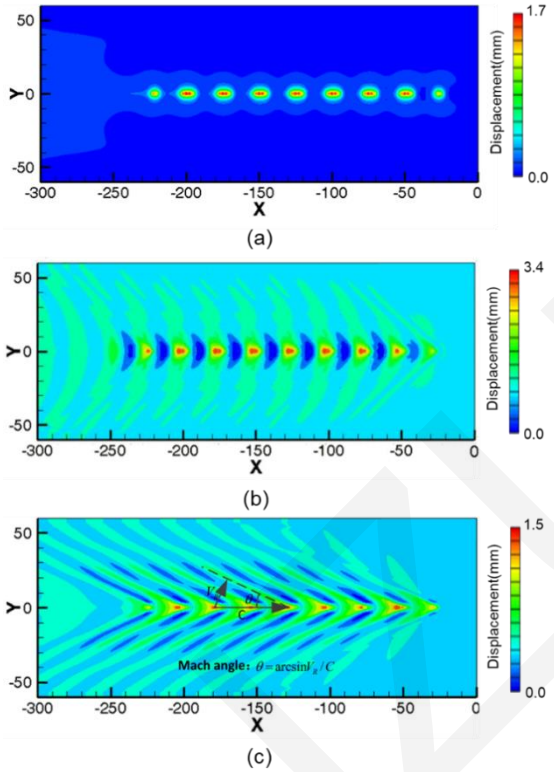
Subgrade problems

- **Subgrade problems caused by extreme climate and train loads**

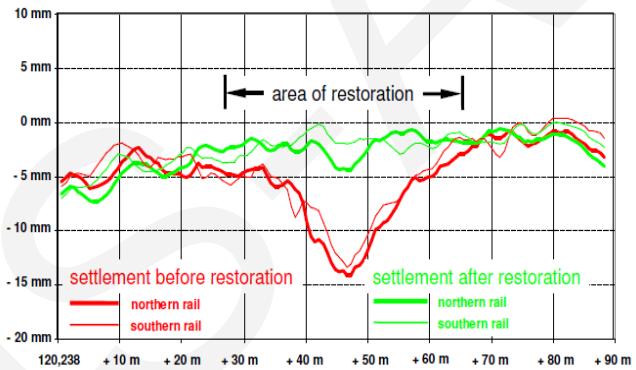


Subgrade problems

- Types and characteristics of typical subgrade problems



Strong vibration and shock by high-speed train



Track settlement



Ballast fouling

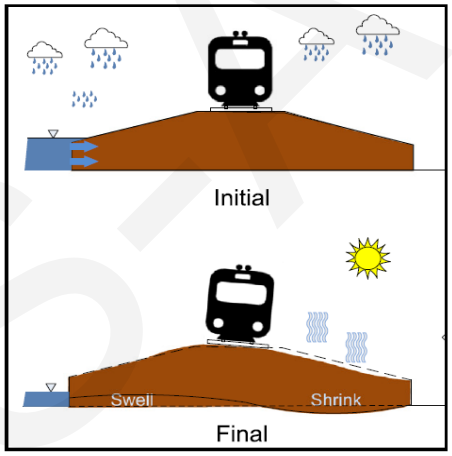
Sánchez et al., Transportation Geotechnics , 1(4): 257-74. 2014
Bian et al., Acta Geotechnica, 11(2): 281-94, 2014.

Subgrade problems

- Types and characteristics of typical subgrade problems



Mud pumping of Ballasted track



swelling–shrinkage behavior



Mud pumping of Ballastless track



Frozen action

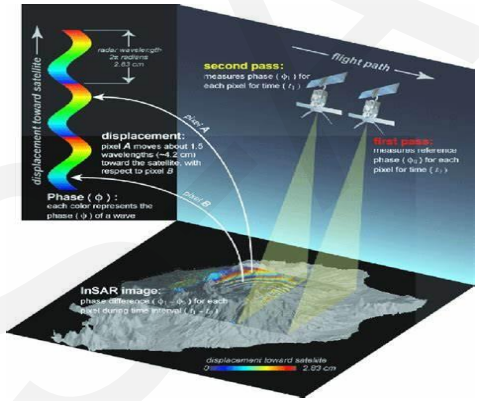
Wan et al., Construction and Building Materials, 259: 120401, 2020.
Indraratna B et al., Canadian Geotechnical Journal, 57(11): 1767-79, 2020.

Subgrade detection and monitoring

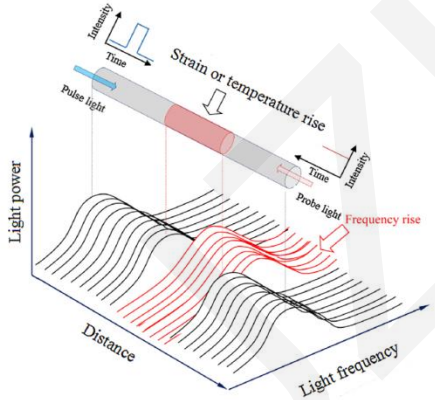
Subgrade detection and monitoring technologies



Ground penetrating radar (GPR)



Synthetic Aperture Radar Interferometry (InSAR)



Fiber sensors

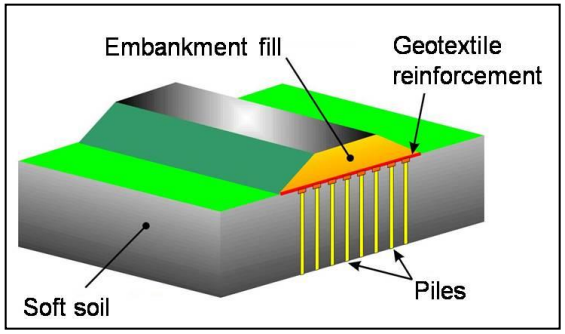


Time domain reflectometry (TDR)

Chen et al. Geotechnical Testing Journal, 37(1) ,2014.
Hong et al., Sensors and Actuators A: Physical, 258: 131-45, 2017.

Subgrade maintenance

Subgrade maintenance method



Pile-supported embankment



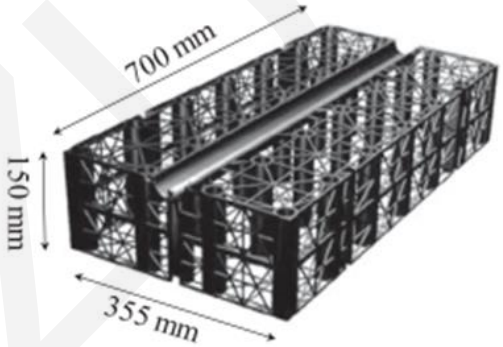
Elastotrack



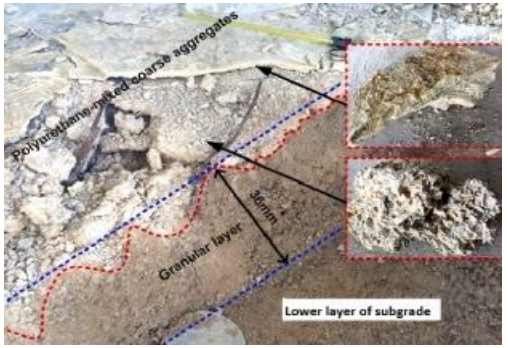
Neoballast



Geosynthetics



geocellular system



polyurethane chemical injection

Bian et al., Transportation Geotechnics, 26, 2021.
Tasalloti A et al., Transportation Geotechnics, 22,2020.
Fontser èV et al., Transportation Research Procedia, 14: 1847-54, 2016.

Conclusions

- The service life of a railway is 100 years, including safe operations, performance degradation, and unsafe service periods. At present, high-speed railways in China have been operating for more than 10 years and have gradually entered the decayed performance period. As a result, studying the change in subgrade performance under train and environmental loads is necessary.

JZUSA