Settlement Behaviour Due to Cyclic Coad Application on a Turnout Sleeper

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This study focuses on sleeper settlement behaviour due to cyclic vertical loads, particularly on a turnout sleeper. Therefore a long sleeper was used in a laboratory box test. This investigation helps to estimate the ballast deterioration at turnouts and thus gives an assessment of the rail track service life. Measurements show that a under sleeper pad (USP) can decrease the ballast deterioration.

Introduction

Maintenance and exchange of rail sections are laborious and costly. A solid track design can help reduce the maintenance requirements and increase the service life. This leads to lower service costs.[1]

When the track deteriorates over time, maintenance is needed to restore the original state to ensure safe and comfortable train service. Settlement can not be easily modelled or predicted computationally or experimentally. Thus the experimentally investigated settlement is often used as a estimation of the potential of the settlement.[2] With the following investigation influences of under sleeper pads as well as force and load frequency on track displacement can be estimated.

Methods

For the test configuration a large box with the dimensions of 5.5 m x 1.5 m x 0.5 m was used for the ballast and the sleeper. The force was provided by a hydraulic load generator. Installed sensors included laser displacement sensors for the top side and pressure sensors for the bottom side of the sleeper. Two setups have been tested, one with and one without an USP. For both setups a test program was applied in which the force ranged from 80 kN to 120 kN and the load frequency varied between 3 Hz and 5 Hz. Over 3.5 million load cycles were carried out.

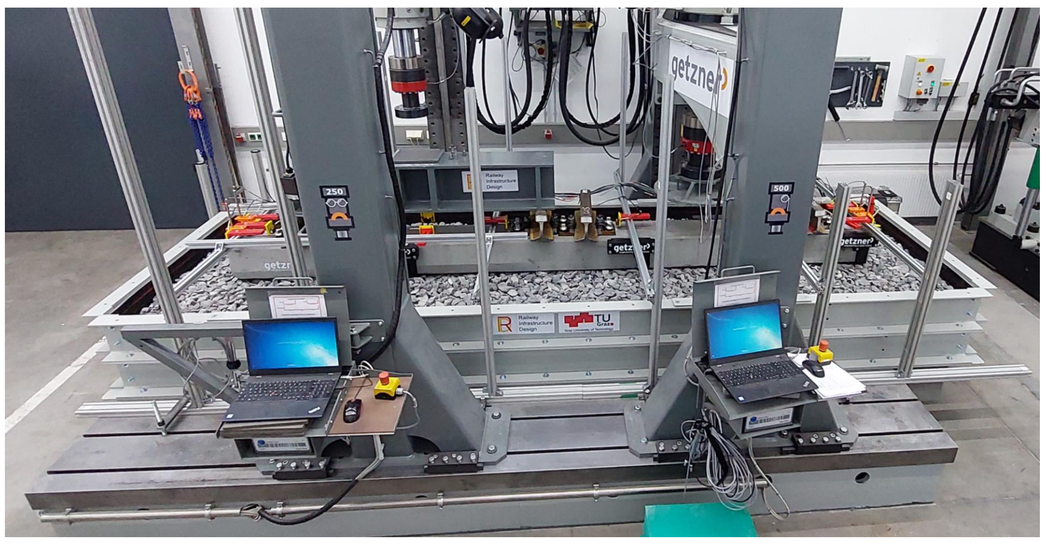

Fig.1: Test setup

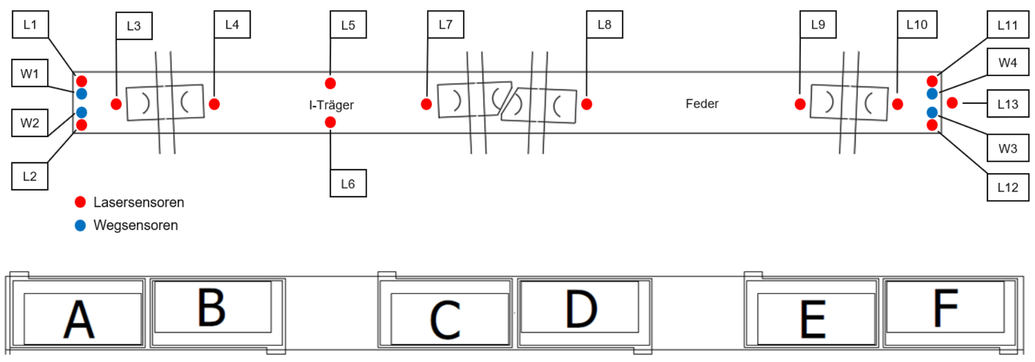

Fig.2: Distribution of displacement and pressure sensors on the sleeper

Results

The diagrams (Fig.3 to Fig.5) show a significant higher settlement for sleepers without USP. Additionally the sleeper without USP is already close to the final settlement at the beginning on the other hand the sleeper with USP goes through a gradually process from small to high settlement. In both cases most of the settlement takes place at the beginning and then subsides.

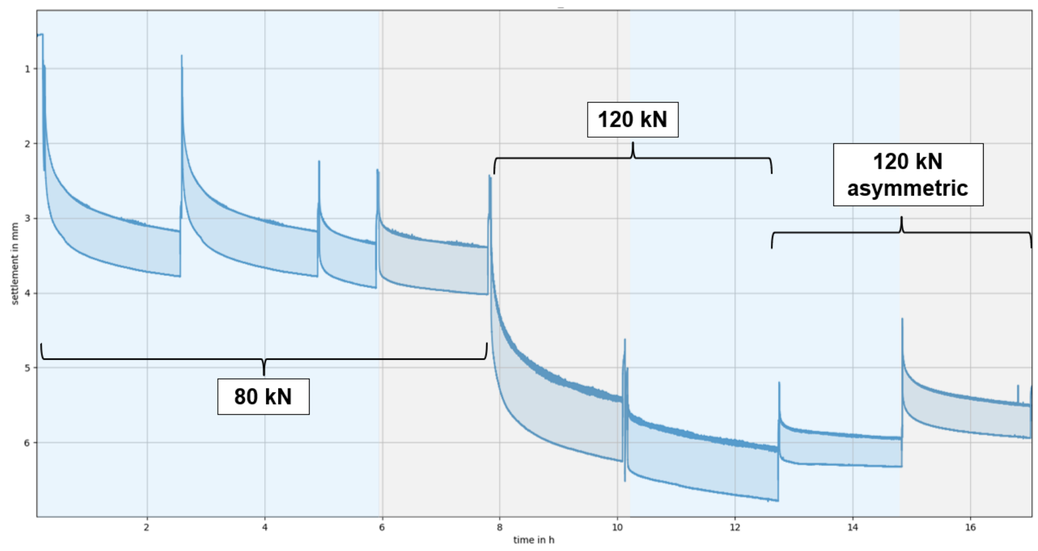

Fig.3: Left side settlement with USP

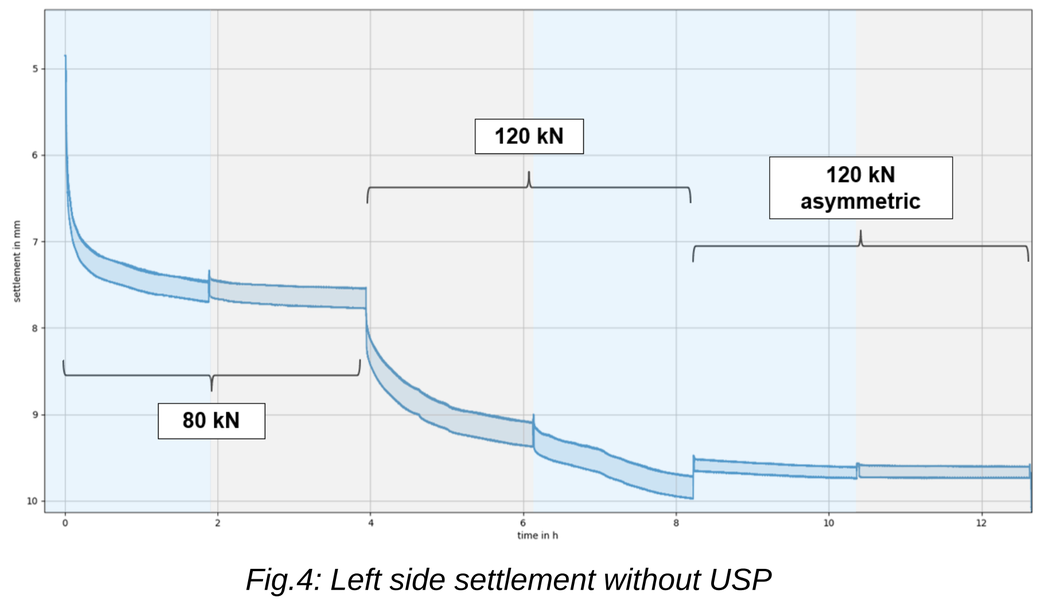

Fig.4: Left side settlement without USP

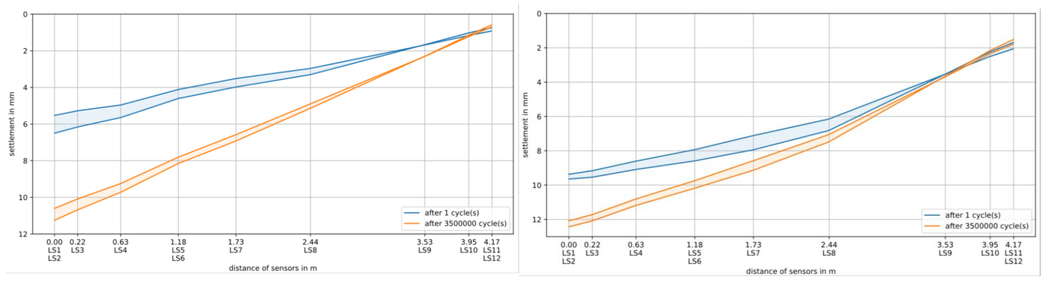

Fig.5: Settlement of the whole sleeper after 1 and 3,5 mio load cycles, with USP (left) and without USP (right)

Discussion and Conclusion

Under sleeper pads can reduce the deterioration of the ballast and increase the ride comfort index of the train. To increase the significance of the test it is recommended to carry out statistical tests with a high number of test runs. The characteristics of every ballast superstructure is a bit different because of the grain distribution and that makes it difficult to evaluate the results.

The characteristics of the sleeper can contribute to higher service life of the tracks and reduce maintenance costs. It is not clear what conditions leads to a minimum of ballast damage and the best settlement behavior. Future studies should look deeper into the interactions between settlement and sleeper characteristics.

References

[1] Abadi, Taufan; Le Pen, Louis; Zervos, Antonis; Powrie, William (2018): Improving the performance of railway tracks through ballast interventions. In *Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit* 232 (2), pp. 337–355. DOI: 10.1177/0954409716671545.

[2] Abadi, Taufan; Le Pen, Louis; Zervos, Antonis; Powrie, William (2016): A Review and Evaluation of Ballast Settlement Models using Results from the Southampton Railway Testing Facility (SRTF). In *Procedia Engineering* 143, pp. 999–1006. DOI: 10.1016/j.proeng.2016.06.089.

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