

Longitudinal resistance performance of granular ballast beds under cyclic symmetric displacement loading

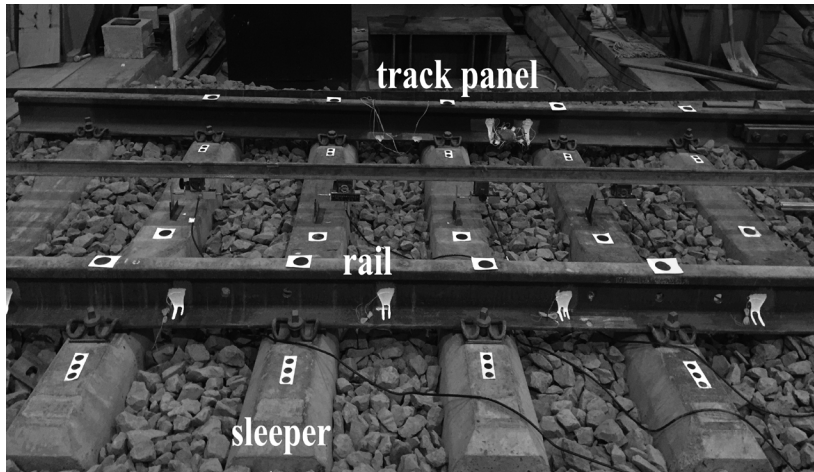
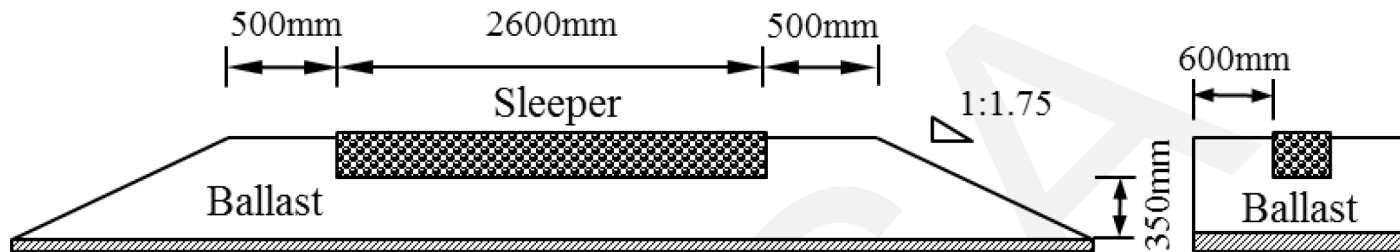
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Highlights

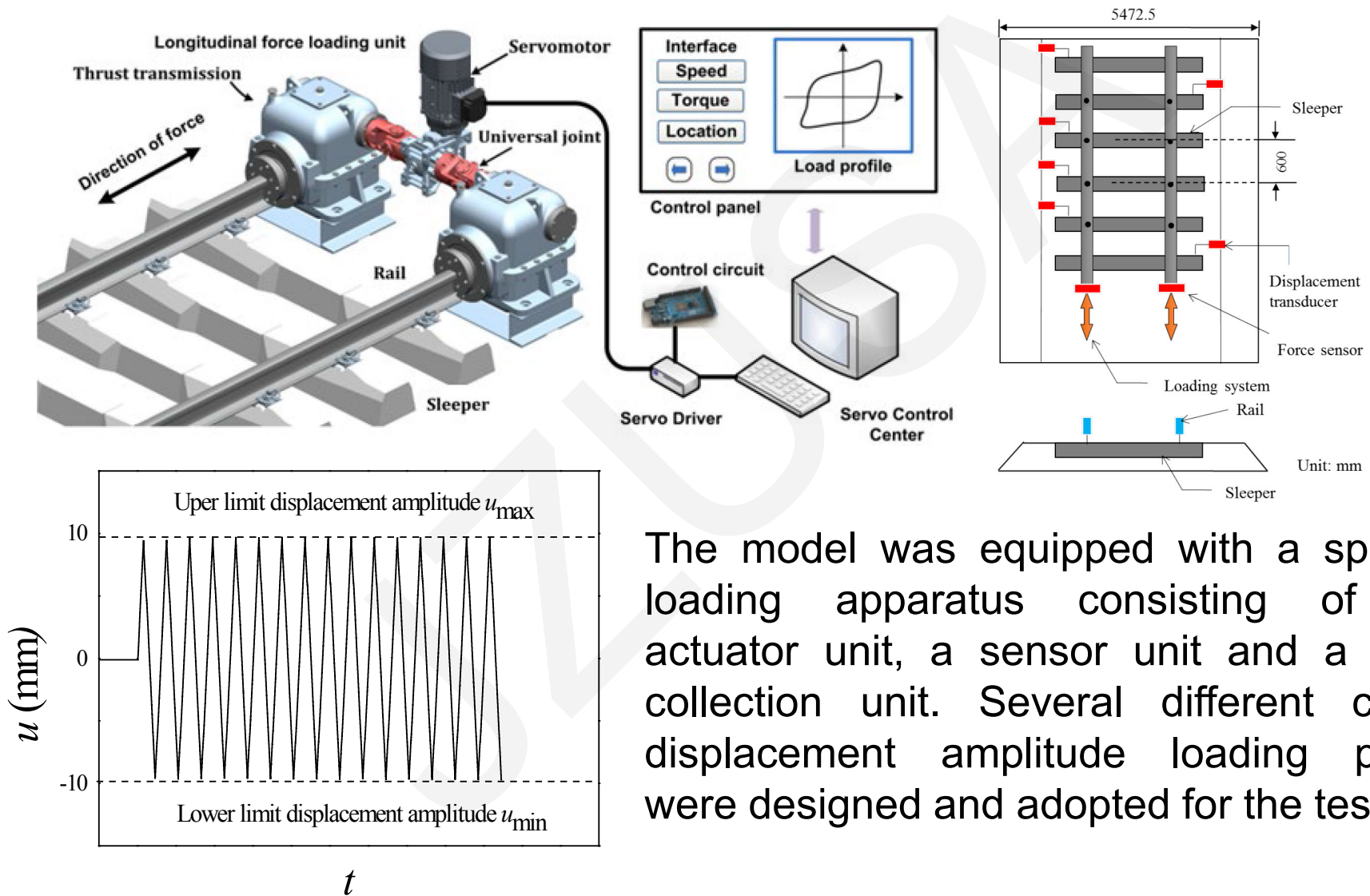
- ❑ The dynamic behavior and stabilization mechanism of granular ballast bed under cyclic longitudinal loading are investigated.
- ❑ The ballast longitudinal resistance-displacement hysteretic curves under cyclic loading are obtained and analyzed.
- ❑ Morphological characteristics model of the ballast resistance-displacement hysteretic curve is established, and its longitudinal bearing and force transmission performance are described.
- ❑ Images of the ballast surface are taken for observing and measuring the motion of ballast grains .

Layout of the test model



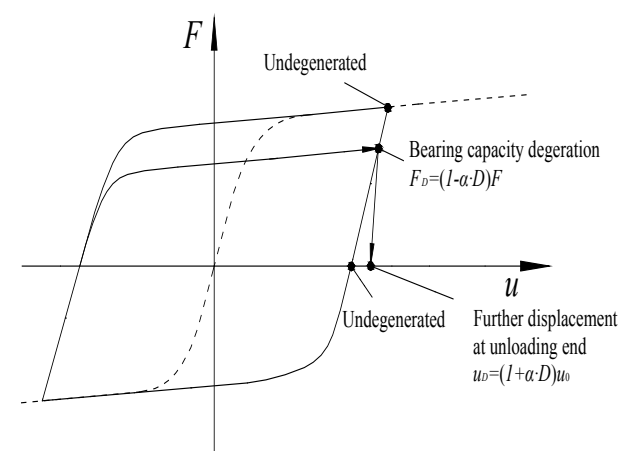
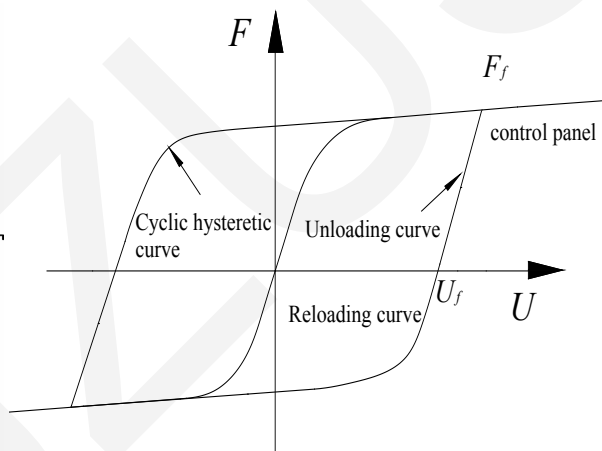
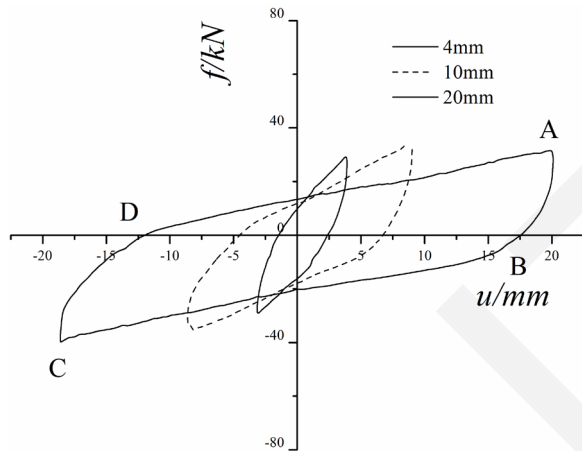
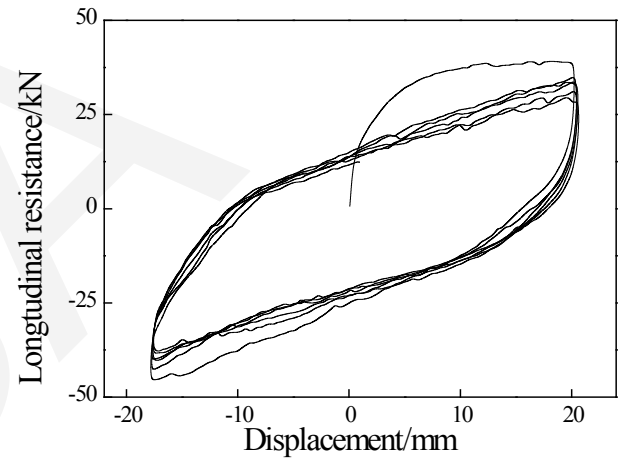
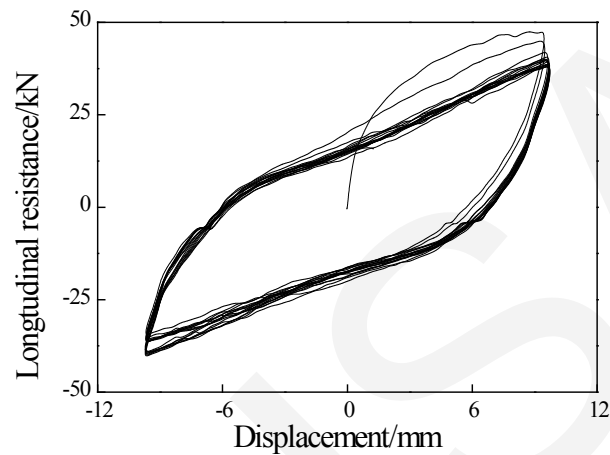
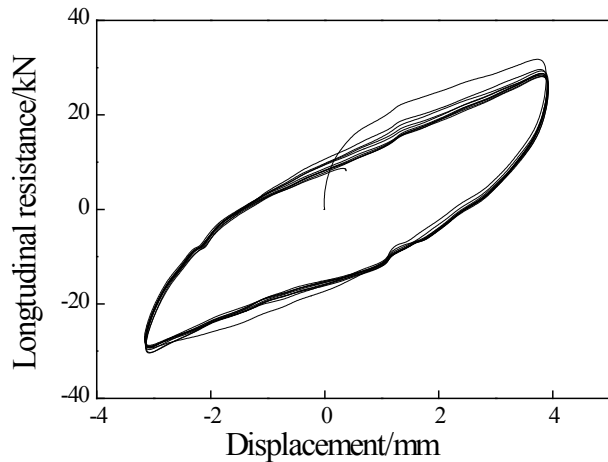
The model track had a CHN60 rail and type-III concrete sleepers with shoulders. The sleeper spacing was 0.6 m. The top width was 3.60 m and the thickness 0.35 m. The slope of the ballast shoulder was 1:1.75. The piled ballast shoulder was 0.15 m. The ballast bed was paved with Class I materials.

Test program



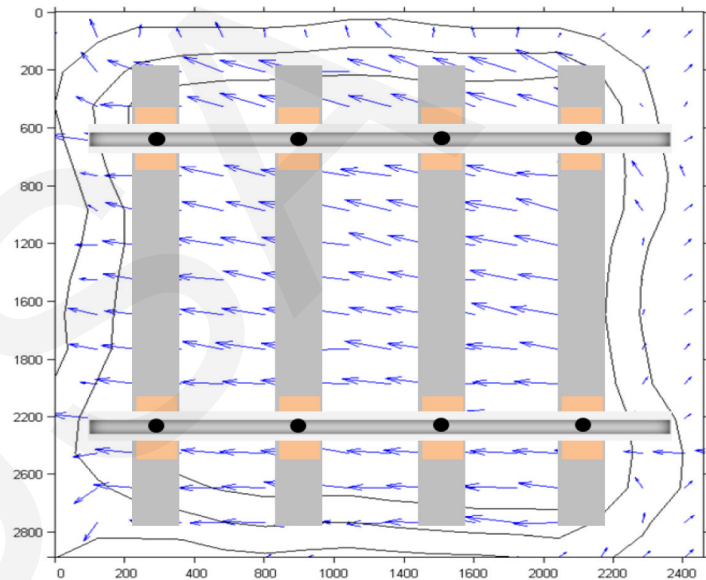
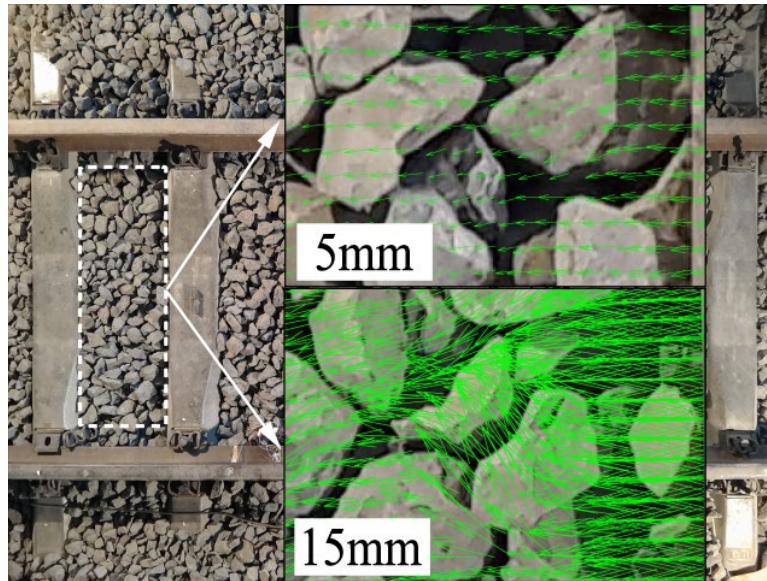
The model was equipped with a special loading apparatus consisting of an actuator unit, a sensor unit and a data collection unit. Several different cyclic displacement amplitude loading plans were designed and adopted for the test .

Hysteresis curves



The ballast resistance-displacement curves are a set of closed hysteretic curves, indicating obvious energy consumption; a granular ballast bed softens gradually during the cyclic process.

Motion of ballast grains



The ballast bed is subject to a relatively stable energy consumption state under longitudinal cyclic loading when the displacement amplitude is low. Compared with the initial loading state, the ballast grains will move slightly after a certain number of cycles. However, under a high displacement amplitude, the positions of the ballast grains change obviously, the ballast bed gradually loosens and is subject to apparent cyclic softening.

Conclusions

- ❑ The ballast resistance-displacement curve of is a closed hysteretic curve under cyclic loading, indicating obvious energy consumption.
- ❑ For a ballast bed subject to durable dynamic reciprocated changes, the transference capacity of ballast longitudinal force is directly dependent on displacement amplitudes.
- ❑ The attenuation rate of the longitudinal resistance of a ballast bed changes with displacement amplitudes. The higher the displacement, the more apparent the degeneration effect will become.
- ❑ For some special CWR track sections, the decrease of resistance caused by a change of ballast bed conditions under high cyclic displacement loading should be given appropriate consideration.