

Development of repair method using polymer for ballasted tracks with a high-mixture ratio of fine particles

Railway Technical Research Institute

Takahisa NAKAMURA, Katsumi MURAMOTO,
Yoshihiko YABUNAKA and Kiyonori NOMURA



Railway Technical Research Institute

Outline

- Background of this study
- Outline of the new repair method by polymer-stabilized ballast bed with a high- mixture ratio of fine particles
- Direct shear test
- Full-scale model test
- Conclusions



Railway Technical Research Institute

Outline

■ Background of this study

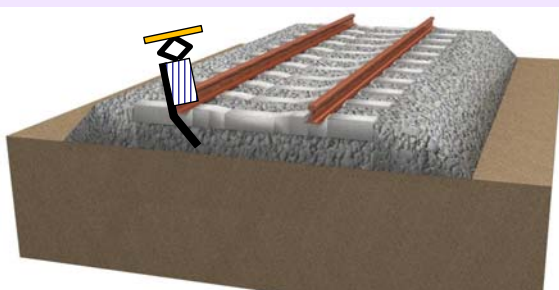
- Outline of the new repair method by polymer-stabilized ballast bed with a high- mixture ratio of fine particles
- Direct shear test
- Full-scale model test
- Conclusions



■ Background of this study

*Ballasted bed with **low**-mixture ratio of fine particles*

Track repair method by tamping

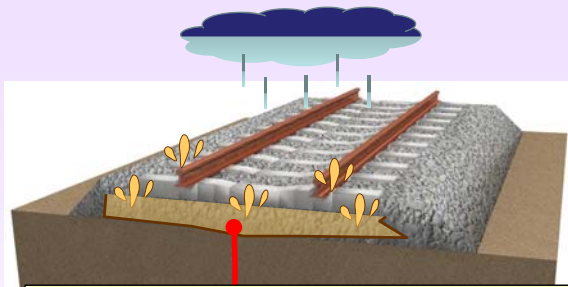


【Track maintenance on ballasted bed with low-mixture ratio of fine particles】

The track irregularity after the track repair by tamping is small and the growth of track irregularity is also small.



Ballasted bed with *high-mixture ratio of fine particles*



- Decrease in strength of ballast
- Mud pumping



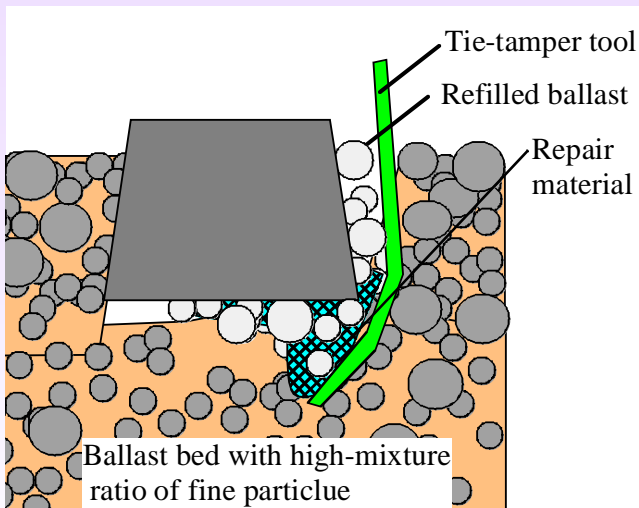
- Track irregularity tends to increase because of a decrease in a strength of the ballast bed and mud pumping due to a increase of water content.
- It is necessary to renew the ballast as drastic measures, however ballast renewal takes costly.

⇒The authors developed the effective track repair method without ballast renewal for that ballast bed.

Outline

- Background of this study
- Outline of the new repair method by polymer-stabilized ballast bed with a high- mixture ratio of fine particles
- Direct shear test
- Full-scale model test
- Conclusions

Outline of the new repair method by polymer- stabilized ballast bed with a high- mixture ratio of fine particles



【Feature】

- This method is to perform the tamping by tie-tamper after throwing in the repair material.
- Ballast bed is stabilized by this method.

- Prevent of the reduction of the shear strength of the ballast bed with a high-mixture ratio of fine particles due to a increase in a high water content
- Increase of the bearing capacity of sleepers

7

Outline of the new repair method by polymer- stabilized ballast

Components of repair material

Material	Specification	Remark
PVA	Poly vinyl alcohol water	Soil stabilizer
Accelerant material	Sodium silicate	Soil stabilizer



PVA



Accelerant material



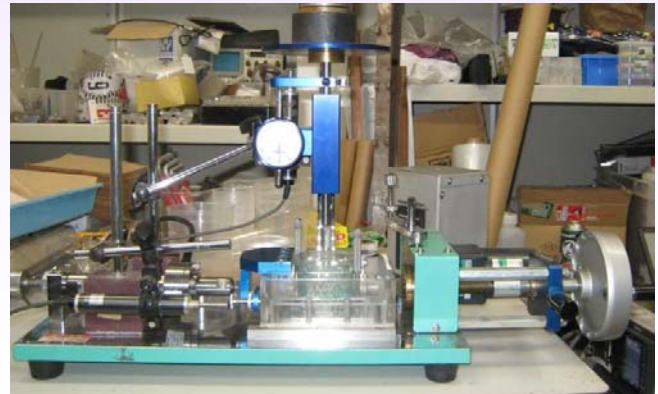
Polymer-stabilized ballast

- PVA reacts with sodium silicate to form gel thereby it is possible to perform the stabilization of the ballast.

8

Outline

- Background of this study
- Outline of the new repair method by polymer-stabilized ballast bed with a high- mixture ratio of fine particles
- Direct shear test
- Full-scale model test
- Conclusions



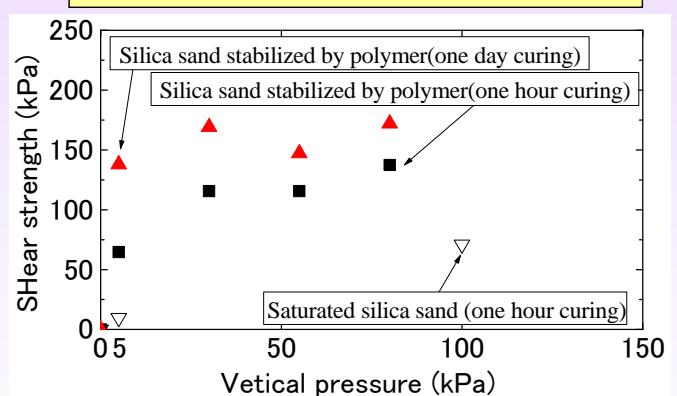
Direct shear test

Direct shear test was performed to evaluate the strength properties of polymer- stabilized ballast bed.

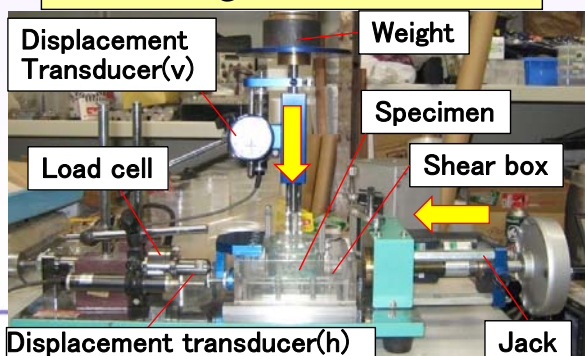
Test case

CASE	Specimen	Curing time
1	Saturated silica sand	1 hour
2	Silica sand stabilized by polymer	1 hour 1 day

Direct shear test result



Loading test condition



- Strength properties of polymer-stabilized ballast
 ⇒ Internal friction of the aggregate
 + Cohesion of the polymer

Outline

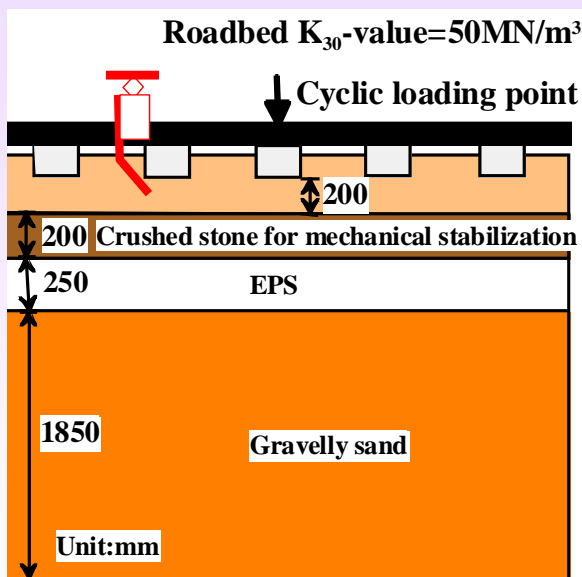
- Background of this study
- Outline of the new repair method by polymer-stabilized ballast bed with a high- mixture ratio of fine particles
- Direct shear test
- Full-scale model test
- Conclusions



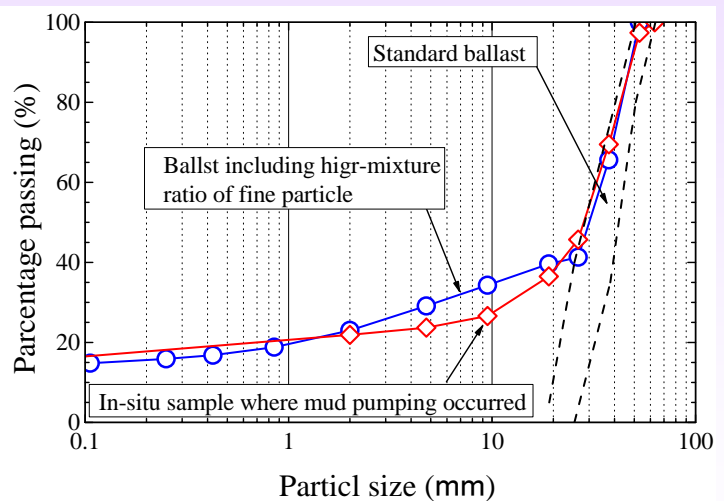
Railway Technical Research Institute

Full-scale model test

Schematic of full-scale model



Particle size distribution curve of ballast with a high-mixture ratio of fine particles



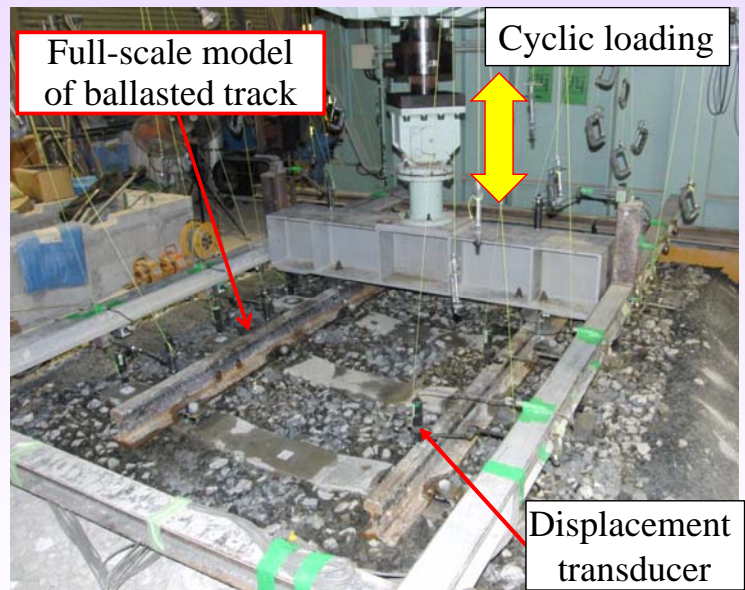
- A full-scale model test was performed to investigate the effect of this repair method by polymer-stabilized ballast bed

Full-scale model test

Test condition of Full-scale model test

Number of times of cyclic loading	600,000 times
Loading frequency	5Hz
Loading amplitude	80kN
Loading wave	Sine wave
Sprinkling water	10L/m ² (after cyclic loading of 300,000 times)

Situation of the cyclic loading test

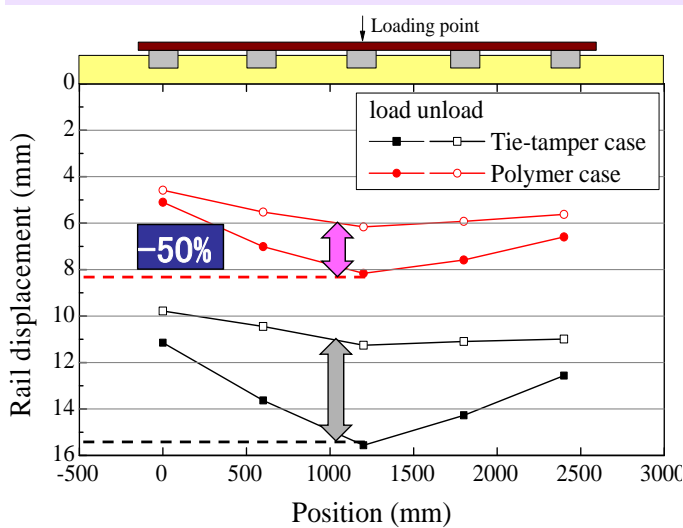


- The effect of this repair method is investigated for the rail settlement due to cyclic loading test

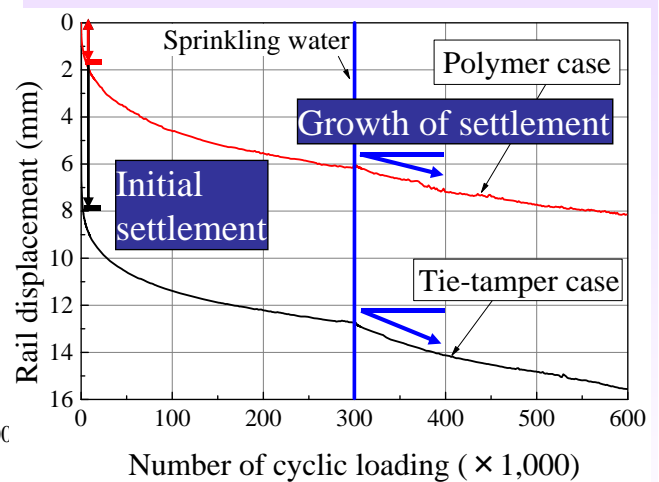


Test result of full-scale model

Distribution of rail displacement



Rail displacement



- The initial settlement and the growth of the settlement after the sprinkling water decrease by this repair method.



Outline

- Background of this study
- Outline of the new repair method by polymer-stabilized ballast bed with a high- mixture ratio of fine particles
- Direct shear test
- Full-scale model test
- **Conclusions**



Conclusions

The authors performed a direct shear test and full-scale model test to confirm the validity of the repair method by polymer-stabilized ballast bed.

- ① By the direct shear test, the strength properties of polymer-stabilized ballast shows that the shear strength after short-term curing for about one hour increase because of both the internal friction of the aggregate and the cohesion of the polymer, and the shear strength after one-day curing increase mainly because of the cohesion of polymer.
- ② By full-scale model test, it has been confirmed that the initial settlement and the process of the settlement after the sprinkling water decrease by this repair method



**Thank you very much
for your kind attention**



Railway Technical Research Institute