

FROST HEAVE CONTROL DESIGN TECHNIQUE FOR THE HIGH-SPEED RAILWAY SUBGRADE IN SEASONAL FROZEN SOIL AREA

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INTRODUCTION

The Frozen soil distributed widely in China, seasonal frozen distribution area accounts for 53.5% of the national. The high-speed railway was constructed in a large scale in the northeast in China, the distance was more than 2000km. Based on the construction experience and research of high speed railway subgrade frost heave engineering in Harbin-Dalian, Panjin-Yingkou, Shenyang-Dandong, Harbin-Qiqihar passenger dedicated line, and the major factors that impact the frost heave control were determined. The mechanism and characteristic of the coarse grained filling were mastered, and the concept of filling was put forward as high permeability, low water capacity and frost heaving. Based on the subgrade structure and site type, waterproof and drainage of subgrade were researched. The synthesis method of anti-frost heave was proposed as waterproof, drainage, dredge and infiltration, and validated through the safety operation in recent years.

Topics and Results

Anti-frost heave design for the high-speed railway subgrade in seasonal frozen soil area.

Blind drain



In lower embankment of filling subgrade section with lower underground water level, setting infiltration blind drain at sidepiece of subgrade to insure the drainage channel smooth.

Monitoring results for various subgrade structures. Application conditions for different subgrade structures.

Packing subgrade



The surface layer of subgrade packing with graded crushed stone, fine particle (particle size ≤0.075mm) content is not more than 5.0% in the range of frozen depth plus 0.25m, and permeability coefficient is not more than 7.0% after compaction.



Concrete subgrade

Monitoring the length of 78km subgrade for 3 years.

- 43% monitoring points' deformations were more than 4.0mm while the surface layer of subgrade was not packed.
- More than 90% monitoring points' deformations were less than 4.0mm while the subgrade was packed completely.

		Maximum deformation				
or not	Amount of monitoring points	≤4mm	4~8mm	8~10mm	10~12mm	
NOT in 20	12	348	292 83.91%	47 13.51%	2 0.57%	7 2.01%
SET in 201	13	715	674 94.27%	39 5.45%	2 0.28%	0 0.00%
SET in 201	14	188	188 100%	0 0.00%	0 0.00%	0 0.00%

Numbers of subgrade sections not set blind drain in 2012 and fortified with this measure in 2013 and 2014.

✓ The percentage of deformation less than 4mm was increased with blind drain measure.

Conclusions

According to the frost heave monitoring results of several railways, such as Harbin-Qiqihar, Mudanjing-Suifenhe and Panjing-Yingkou railway, the railway roadbed frost heave can be controlled by using the technique of controlling the concentration of fine particles in the packing. And the application effect is obviously.

In the lower embankment section of high water level, in which the packing bed frost heave is difficult to control, concrete bed can be used to prevent large frost heave.

In the lower embankment section where drainage of water is difficult, infiltration blind drain is used to speed up the evacuation of the water inside the roadbed, so that to reduce the possibility of large frost heave due to poor drainage.



Using the characteristic of concrete small deformation after frozen to control the frost heave with concrete subgrade bed where the lower embankment section with high level underground water and difficult to drainage.

Various subgrade sections were filling subgrade in 2012 and changed the bed to concrete in 2013 and 2014.

 ✓ The deformation of concrete subgrade was obviously lower than filling subgrade in the same condition.



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