

HIGH SPEED RAILWAY, TIELI-YICHUN HSR HEILONGJIANG PROVINCE, CHINA

# Managing subgrade moisture and frost heave in frozen soil



**Industry:** Transportation  
**Sub-industry:** Railways  
**Location:** China  
**Product:** **MIRAFI**® H<sub>2</sub>Rx

## Overview

China Academy of Railway Sciences Corporation Limited (CARS) is a leader in railway construction, operation, and maintenance, delivering innovations in high-speed railway construction, equipment modernization, and heavy-duty transportation. The institution provides technical services in transportation organization, standards, consulting, quality inspection, energy-saving, and environmental protection. CARS also leads comprehensive and specialty testing for China's high-speed railways, completing joint commissioning and debugging for all high-speed and passenger railway lines in China and several international projects.

CARS has expanded into urban rail transit, leveraging decades of technical expertise. It undertakes tasks such as policy research, standard development, project consulting, testing, and product certification, significantly impacting China's urban rail transit sector.

The Harbin-Yichun High-speed Railway, the first in China to traverse permafrost regions, showcases CARS' innovative approach. Utilizing **MIRAFI** H<sub>2</sub>Rx products, this project enhances subgrade moisture management and controls water content within the frozen soil zone, marking a significant advancement in railway construction technology.

**Managing frozen soil subgrade is a primary challenge. The Tie-Yi Line crosses 14 segments of segregated frozen soil zones, with depths up to 3 m (9.8 ft).**

## CASE STUDY

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### Challenge

The Harbin-Yichun High-speed Railway, particularly the Tieli to Yichun Railway (Tie-Yi Line), presents unique challenges. This high-speed railway, designed for speeds up to 250 km/h (155 mph), spans 112.299 km (69.8 mi) from Tieli City to Wumahe District in Yichun City, passing through primitive forests, water protection areas, and scenic regions like Sun-Moon Canyon National Park, imposing strict environmental protection requirements.

Managing frozen soil subgrade is a primary challenge. The Tie-Yi Line crosses 14 segments of segregated frozen soil zones, with depths up to 3 m (9.8 ft). The region's soil transitions between permafrost and seasonal frozen soil zones, complicating subgrade stability and frost heave prevention.



Construction is also challenged by the terrain of gently rolling hills and floodplains with a high water table near the Yao River. The soft soil subgrade and need to protect sensitive areas add complexity. The project demands innovative moisture management and enhanced subgrade performance while meeting environmental standards.

The construction timeline was tight: design began in July 2022, material procurement in November 2022, construction started in May 2023, and the trial segment was completed by November 2023. Precise coordination and effective management were essential.

### Solution

CARS addressed the challenges of the Harbin-Yichun High-speed Railway by using innovative **MIRAFI H<sub>2</sub>Rx** products. These products, designed by Solmax, feature high tenacity polypropylene yarns with excellent wicking capabilities, ideal for moisture management and frost heave resistance in railway subgrades.

The subgrade moisture management experiment used **MIRAFI H<sub>2</sub>Rx** in three sections of the Tie-Yi Line: K41+480, K41+500, and K41+529.27. Moisture absorption geotextile layers were installed at strategic locations within the subgrade cross-section. The first layer was placed between the subgrade and the bottom subgrade bed, while the second layer was between the surface subgrade bed and the ballast layer, ensuring effective moisture management and frost heave protection.



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During construction, the installation required meticulous detail. The first **MIRAFI H<sub>2</sub>Rx** layer extended 2.0 m (6.6 ft) beyond the embankments, and the second layer extended 3.0 m (9.8 ft). Protection layers of graded broken stones covered these extensions to prevent construction damage.

CARS collaborated with Shandong University for implementation and monitoring, ensuring design and construction met the highest standards and that trial data was accurately collected and analyzed.

Using **MIRAFI H<sub>2</sub>Rx** in this project marked the first use of this technology in China for moisture management and frost heave resistance in a high-speed railway. The geotextile's ability to intercept water penetration and provide high biaxial tensile modulus during freezing and thawing periods significantly enhanced subgrade stability and performance.

This solution addressed the technical challenges of managing frozen soil subgrade and contributed to environmental protection. Moisture absorption geotextile reduced ice lens formation within the soil, minimizing undulations and ensuring

road surface stability during thawing periods. This approach aligned with China's environmental protection initiatives by promoting low-carbon, environmentally friendly construction practices.

In conclusion, the Harbin-Yichun High-speed Railway project demonstrates how innovative engineering solutions, such as **MIRAFI H<sub>2</sub>Rx**, can overcome complex geotechnical challenges while adhering to stringent environmental standards. The project's success highlights CARS' commitment to advancing railway technology and managing large-scale infrastructure projects in challenging environments.

As a follow-up to this success, the new **MIRAFI H<sub>2</sub>Rx** product has been introduced, which offers superior performance for similar applications. **MIRAFI H<sub>2</sub>Rx** enhances road pavements and railway structures with superior load distribution, reinforcement, and moisture-wicking technology. Made with high tenacity polypropylene yarns, it improves soil bonding and durability, addressing subgrade stabilization challenges while ensuring environmental sustainability and resilience in construction projects.



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