

Preface

The construction of the Qinghai–Tibet Railway was a major strategic decision of the Party Central Committee and State Council. It was also a landmark project in Western development. People in the Tibet autonomous region and Qinghai Province looked forward to this project for a very long time, it was an aspiration of the former leaders of the new China and several generations of railway builders.

The Qinghai–Tibet railway started from Xining City, the capital of Qinghai Province, and ended in Lhasa City, the capital of the Tibet autonomous region, with a fulllength of 1956 km. The first stage of the project from Xining to Golmud was 814 km long. It was constructed in 1979 and began operating in 1984. The second stage of the project from Golmud to Lhasa was 1142 km long. It is a high-plateau permafrost railway and is known to be the longest line and run at the highest altitude above sea level of any railway in the world. This railway section crosses a 960 km long area with altitudes greater than 4000 m and a 550 km long area with continuous permafrost, with the highest point at 5072 m in the Tonglha Mountain Pass.

The time limit for the second phase construction of the Qinghai–Tibet Railway was 5 years. Construction began on June 29, 2001, and it officially opened on July 1, 2006 with a designed transport capacity of bus 8, and a freight volume of 5 million tons. The rear channel connecting Lanzhou–Beijing and the Asian–European land bridge is an important main line of our country’s railway network.

During the construction of the Gela section of the Qinghai–Tibet Railway (hereinafter referred to as the Qinghai–Tibet Railway), it was necessary to consider problems that included alpine hypoxia, a complex permafrost condition, a fragile natural environment, long lines, and very difficult engineering tasks. We have some deep feelings to review of the Qinghai–Tibet railway survey and design different types of geological conditions during the line scheme selection and optimization process. Over a period of nearly two years, we summarized the main geological line selection process along the Qinghai–Tibet Railway, analyzed the influence of the geological conditions on the engineering of the line, cited numerous engineering examples, and finally finished the book.

This book reviews the complex geological conditions of the Qinghai–Tibet Railway. In addition, we highlight the characteristics of the Qinghai–Tibet Railway line selection, which had to consider permafrost, earthquakes and active faults, slope geological disasters, environmental protection, geothermal characteristics, wind, and windblown snow.

The book contains seven chapters.

Chapter 1 is an introduction. This chapter provides an overview of the main geological problems and their influence on the Qinghai–Tibet Railway construction, along with the basic principles of railway line selection under various geological conditions.

Chapter 2 reviews the Qinghai–Tibet Railway’s geological environment. In this part, the authors analyze the engineering geological environment of the Qinghai–Tibet Railway, including the Tibetan Plateau’s unique geographical location, topography, lithology, hydrogeological conditions, and permafrost distribution. A variety of other adverse and special geological conditions and climate characteristics, and the ecological environment, are also introduced.

Chapter 3 considers geological line selection in permafrost regions. In this chapter, permafrost is described in detail, including the classification of frozen soil and engineering geological properties. Permafrost does great harm to railway projects, and is likely to cause major disasters such as roadbed frost heaving and thawing settlement, cutting slope collapse, mudflows, frost heaving and thawing settlement of bridge and culvert foundations, deformation and cracking, tunnel heaving and thawing cracking, and icing inside tunnels. This chapter also discusses the principles of line selection in permafrost regions, and lists the main engineering geology instances in the permafrost regions along the Qinghai–Tibet Railway.

Chapter 4 discusses the active fault zone for strong earthquakes and the geological line selection. This chapter explains the spatial distribution of the seismotectonic zones of Kunlun Mountain, Bengcuo, Gulu–Sangshung, and Yambajan–Damxung. It also expounds on the activity rate of faults and major earthquake occurrences. The active fault belts not only affect the local life, but also do great harm to railway engineers. The main problems include landslides, debris flows, a tectonic fracture zone, thawing mud flows, thaw slumping, thermal lakes and ponds, frost heaving, ice pyramids, hummocks, the ice mantle, and permafrost swamps. From the perspective of the threats caused by an earthquake, this chapter mainly explains some of the damages from the Ms 8.0 Yambajan earthquake, Ms 8.0 Bengcuo earthquake, Ms 7.5 Jiuzina earthquake, and Ms 8.1 Kunlun Mountain earthquake. Therefore, when railway engineering is conducted in active fault zones and strong earthquake areas, a serious investigation is needed to determine the active faults along the railway and perform seismic intensity zoning. An economical and reasonable railway can only be constructed after the selection principle and engineering protection measures are developed. This chapter finally introduces some engineering examples of geological line selection in high earthquake-intensity areas and active fault zones.

Chapter 5 discusses railway line selection in a slope area with geological hazards. In this chapter, slope classification and its distribution law are first introduced.

Then, the negative influences on the construction of the Qinghai–Tibet railway are analyzed, including those from dangerous rocks, rock falls, landslides, collapse, rock heaps, debris flow, thaw slumping, and slope wetland. The route selection principle for slope geological hazards and prevention measures for these hazards are also included. In addition, it elaborates on the analysis procedure in a scheme comparison, and the reason that we chose one scheme rather than another.

Chapter 6 examines railway line selection in nature reserves. This part introduces the general situation of nature reserves, with a detailed description of the relationship between nature reserves and railway locations. It introduces the principles used when selecting the optimum route, emphasizes the importance of railway line selection in the Sanjiangyuan and Kekexili nature reserves, and points out the influence of a railway on an ecological environment and solutions to mitigate this influence.

Chapter 7 focuses on geothermal geological line selection in sand and wind-blown snow areas. This chapter is divided into three parts. The first section considers geological line selection in a geothermal area, introducing the distribution and classification of geothermal zones, and the engineering characteristics in our country, along with analyzing the geothermal influence on railway engineering, and formulating the principles of line selection in a geothermal area. The second section examines geological line selection in a wind-sand area. It expounds on the causes for the formation of sand and the motion law of the Qinghai–Tibet plateau, and analyzes the effects of sand on railway engineering and the principle for selecting a sand area and protective measures. The third section discusses geological line selection in a now drifting area, illuminates the reason for the formation of windblown snow disasters on the Qinghai–Tibet plateau and the motion law, analyzes the influences of windblown snow and avalanches on railway engineering, and introduces the principles for selecting wind snow areas and protective measures.

Because of the special climatic environment, complicated permafrost geological conditions, high seismic intensity, large number of active fault zones, and especially fragile natural ecological environment, great attention was given to railway line selection from the very beginning of reconnaissance on the Qinghai–Tibet Railway. The unremitting efforts of explorers and scientific and technical personnel made it possible to determine the main geological problems along the railways, especially the distribution characteristics and development law of permafrost, which provided a powerful guarantee for the success of the final railway line selection and decreased the capitalized cost to the minimum margin.

Railway line selection is a comprehensive process, which requires a comprehensive consideration of outside factors. One of the characteristics of this book is a discussion of the Qinghai–Tibet Railway route selection exclusively from the aspect of the influence of geological conditions. In this book, we provide our consideration and experiences when we made the decision under the involved main geological conditions at the end of every chapter to remain space for readers to think and discuss.

This book was based on the large amount of data collected and a summary of survey and design reports, information, design documentation, and published articles about the Qinghai–Tibet Railway. Adhering to the principle of taking our side as the dominant factor, the engineering projects discussed in the book and the final route selection decisions were conducted under practical survey and design service professionals working in the circuit, subgrade, geology, bridge and tunnel, and environmental protection fields, which sufficiently shows the collective intelligence.

Xi'an, China
Lanzhou, China
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Jincheng Li
Wenwu Chen

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Li, J.; Wang, N.; Liu, Z.

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