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# 青藏铁路片石气冷护坡措施实体工程试验研究

魏 静<sup>1, 2</sup>, 许兆义<sup>1</sup>, 包黎明<sup>2</sup>, 葛建军<sup>2</sup>

(1. 北京交通大学 土木建筑工程学院, 北京 100044; 2. 铁道第一勘察设计院, 陕西 西安 710043)

收稿日期 2005-4-12 修回日期 2005-8-1 网络版发布日期 2006-12-31 接受日期 2005-4-12

**摘要** 为解决在高温、高含冰量冻土地段修筑铁路工程后的路基稳定性技术难题, 在路基工程的设计中采用主动保护多年冻土的措施——片石气冷护坡, 通过调控路基下地温场以阻止或减少由于多年冻土地基融化下沉而引起的路基变形。在青藏铁路清水河高温冻土细粒土段进行片石气冷护坡路堤和普通路堤实体工程对比试验, 基于3个测试断面、2个冻融循环的地温和变形监测资料, 对比分析片石气冷护坡路堤与普通路堤体内和基底的地温、积温、温度场中最大融化深度的变化情况以及路堤的变形特征。分析结果表明, 采用片石气冷护坡措施的路堤, 与普通路堤相比, 降温效果明显, 负积温量值大, 最大融化深度抬升幅度也较大, 沉降量小。因此, 片石气冷护坡能够有效发挥降低地温、保护多年冻土的作用, 是一种施作方便、适用条件较广泛的主动保护多年冻土措施。

**关键词** [边坡工程](#); [青藏铁路](#); [片石](#); [地温](#); [积温](#); [沉降](#)

分类号

## EXPERIMENTAL STUDY ON AIR-COOLING EMBANKMENT WITH RUBBLE SLOPE PROTECTION ALONG QINGHAI—TIBET RAILWAY

WEI Jing<sup>1, 2</sup>, XU Zhaoyi<sup>1</sup>, BAO Liming<sup>2</sup>, GE Jianjun<sup>2</sup>

(1. School of Civil Engineering and Architecture, Beijing Jiaotong University, Beijing 100044, China;  
2. The First Railways Survey and Design Institute, Xi'an, Shaanxi 710043, China)

### Abstract

The construction of Qinghai—Tibet Railway in permafrost regions is mainly confronted with three frozen soil problems, i.e. the thaw settlement, frost heaving and unfavorable features related to frozen ground. Among which the thaw settlement is a main reason for embankment deformation and destruction. Therefore, it is the chief problem to resolve in the engineering design for railway embankment due to the unique natural conditions on the Qinghai—Tibet Plateau. Furthermore, under the condition of global warming, in addition of keeping the landform, terrain and hydrological conditions of permafrost regions, the design should be initiated from railway embankment structure itself to create a proper condition beneficial for permafrost existence or development. To solve embankment stability problem in high temperature and high ice content area after the railway construction, a kind of positive measure to protect permafrost, i.e. air-cooling embankment with rubble slope protection, was designed to control ground temperature field in case of embankment deformation caused by permafrost thawing. Hence, experimental project, air cooling embankment with rubble slope protection and common embankment were designed and conducted in Qingshuihe, a field test section of high-temperature fine grain frozen soil region along Qinghai—Tibet Railway. Based on monitoring data of ground temperatures and settlement for three sections after two freezing-thawing cycles, the ground temperature, accumulated temperature, maximum thawing depth variation and deformation feature of these two kinds of embankments

were analyzed comparatively. It was shown that the air-cooling embankment with rubble slope protection showed a better effect on decreasing ground temperature, lowering minor accumulated temperature, elevating the maximum thawing depth evidently and reducing settlement than those of common embankment. Therefore, the air-cooling embankment with rubble slope protection, as a kind of conveniently and widely used construction measure, was a positive frozen soil protection measure for its effectively decreasing ground temperature and protecting permafrost.

**Key words** [slope engineering](#); [Qinghai—Tibet Railway](#); [rubble](#); [ground temperature](#); [accumulated temperature](#); [settlement](#)

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