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块石路堤上覆砂砾石厚度对冻土路基冷却效果的影响研究

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摘要　用数值模拟的方法得到不同上覆砂砾石厚度的块石路堤及普通路堤作用下铁路路基的温度场，通过对比分析显示：块石路堤相对于普通路堤能明显提高路基下多年冻土上限，降低多年冻土地温，有较强的主动制冷作用；块石上覆砂砾石厚度的增加，会减弱块石的制冷作用，降低路基多年冻土上限；当砂砾石大于某一厚度时，中部一定范围的块石几乎丧失主动制冷能力，多年冻土地温逐渐升高，这对路基稳定及冻土保护极为不利。考虑全球气候变暖趋势及高路堤带来的高荷载影响，建议块石路堤上覆砂砾石不要太厚，应寻求制冷与多年冻土上限抬升两者兼得的最优厚度。

关键词　土力学；块石路堤；冷却效果；青藏铁路；数值模拟
分类号

STUDY ON INFLUENCE OF SAND-AND-GRAVEL LAYER THICKNESS UP BLOCK-STONE RAILWAY EMBANKMENT ON COOLING EFFECT OF FROZEN-SOIL FOUNDATION

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Abstract

In block-stone embankment construction of Qinghai—Tibet railway，different thicknesses of upper sand-and-gravel layer and same thickness of block-stone layer were used in different railway segment due to the uneven landform. By numerical stimulation，the temperature distribution were obtained in common embankment and block-stone embankment with upper sand-and-gravel layer in different thicknesses. The comparative analyses show that block-stone embankment has well active cooling effect on the railway foundation by raising the permafrost table and decreasing the permafrost temperature，and the variation of upper sand-and-gravel layer thickness has also great influence on the active cooling effect. The thicker the upper sand-and-gravel layer is，the smaller the temperature variation magnitude on the top of block-stone layer conducted from the embankment surface is，which will slow down the convection speed of the air in block stone and weaken the cooling ability of block stone. Although the permafrost table under the center of the embankment lifts up with thicker upper sand-and-gravel layer，the cost is the frozen intensity decreasing of the permafrost and the dissipation of cold generated by the block stone near the embankment foot. On the conditions given by the model，the cooling ability of block stone is stronger than that of heat disturbance caused by embankment construction when the thickness of upper sand-and-gravel layer is less than 6

m or larger than 9.5 m. The cooling of block stone near the embankment foot and the cold supplying of around permafrost can not counterweigh the heat effect of embankment anymore and the permafrost table under the center of the embankment will go down gradually. In sum，the increase in the thickness of upper sand-and-gravel layer will weaken the active cooling ability of block stone and lower the permafrost table beneath the railway embankment，and while the thickness exceeds a certain number the middle zone of block stone will almost loss the cooling capability and thus lead to an increase of permafrost temperature，which is disadvantageous to the stability of railway embankment and the protection of cold ground. Considering the warm tendency of global climate and the heavy load of high embankment，we suggest the discussion of thick sand-and-gravel layer up the block-stone embankment and seeking an optimal thickness of upper sand-and-gravel layer and block stone layer in construction.
Key words soil mechanics；block-stone railway embankment；cooling effect；Qinghai—Tibet railway；numerical simulation

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