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木寨岭隧道大变形特征及机理分析

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摘要　木寨岭隧道是国道212线改建中的控制性工程，地处青藏高原东北缘，地质条件复杂。隧道埋深大且地应力高，地下水丰富，断层发育，有5条大断层(总厚度273 m，占全隧道长度的21.9%)，岩体软弱破碎，隧道自稳能力差。隧道建设过程中，产生强烈变形和严重破坏。隧道最大累计下沉和水平收敛分别达1.712和1.081 m；围岩初期变形迅速，变形速率大，变形持续时间长，隧道破坏严重，主要表现为拱顶下沉、边墙内挤、喷混凝土剥落、钢拱架扭曲、底鼓及仰拱开裂翘起、衬砌开裂等；变形破坏具有重复性和相似性。从围岩的岩性条件、地下水条件、地应力条件以及隧道变形破坏特征等方面，探讨了该隧道大变形的原因和机制，认为它是围岩塑性流动与围岩膨胀变形综合作用的结果。基于对围岩动态演化机制的正确认识，从围岩控制角度，修正并制定新的返修方案，对大变形段实施返修并取得了成功，同时将研究成果用于指导相同地质条件的后洞段施工，确保了隧道安全顺利贯通。

关键词　隧道工程；大变形；膨胀；塑性流动；软岩；断层带

分类号

RESEARCH ON LARGE DEFORMATION AND ITS MECHANISM OF MUZHAILING TUNNEL

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Abstract

The Muzhailing tunnel，a key project of reconstruction of the national highway G212，is located in the northeastern Qinghai-Tibet plateau and traverses the Muzhai mountain. The very complex geological environments，such as high earth stress，deep-buried，rich groundwater，five faults zone with total width of 375 m (21.9% of the tunnel) and very weak and cracked rock masses influenced by groundwater and above-mentioned faults，make self-stability of the tunnel be unfavorable. During construction，intense deformation and serious failure happened. The monitoring data show that deformation was rapid with long duration. The maximum cumulative vertical and horizontal displacements reached to 1.712 m and 1.081 m，respectively in fault F2. Many serious failures happened due to large deformation，for example，roof subsidence，wall crushing，shotcrete flaking，S-shape twisted steel support，broken lining，floor upheaval，invert crazing and lots of cracks distributed everywhere. The surrounding rocks were reinforced and the tunnel was repaired for many times，but large deformation and bad damage did not stop；and previous intrinsic characteristics continued. By analyzing surrounding rocks，groundwater，earth stress as well as deformation characteristics，the reason and mechanism of large deformation of this tunnel were discussed. It is plastic flow and swell of surrounding rocks that are resulted in large deformation jointly. Based on correct understanding of dynamic evolution mechanism of the surrounding rocks，a new reinvention and reinforcement program was adopted from the viewpoint of controlling surrounding rocks. Those parts including large deformation and serious failure

were repaired successfully. The construction of the tunnel through the rest of fault F2 and other faults benefited from the research results. The Muzhailing tunnel is achieved safely and successfully at last.
Key words tunneling engineering；large deformation；swell；plastic flow；soft rock；fault zone

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