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Investigation and analysis on Seismic Damages of Mountain Tunnels Subjected to Wenchuan earthquake

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Keywords: Wenchuan earthquake; mountain tunnels; seismic hazards; corresponding measures

Abstract: Wenchuan earthquake of May 12 struck China with amazement in 2008, which inflicted the devastating destruction to the public transport infrastructures in Sichuan province. Generally speaking, underground structures have the stronger seismic resistance performance compared to ground-level structures. However, seismic disasters of mountain tunnels were fairly conspicuous after the earthquake. Based on the references about tunnel earthquake damages at home and abroad (Dowding and Rozen, 1978; Huo, 2005; Rozen, 1976; Youssef, 2001; wang, 2001), more attentions should be paid to the prevention and mitigation of tunnel seismic hazards under severe intensity earthquakes. This paper describes some typical earthquake damages to mountain tunnels during Wenchuan earthquake and presents the basic characteristics of the tunnel seismic damage as well. Meanwhile, the possible reasons for the seismic damage and the corresponding measures for relieving or resisting the damage are also given.

Introduction

At 14:28 (local time) on May 12, 2008, the sudden strong earthquake with a magnitude of 8.0 (Ms) struck Wenchuan county of Sichuan province in China. The epicenter of Wenchuan earthquake was below the ground surface at about 13km, which triggered the well-known quake at the beginning rupture point near Yingxiu town of Wenchuan. The earthquake continued more than 100 seconds and induced several geological consecutive break-point behaviors along the Longmen-Shan fault (Beichuan~Yingxiu fault). Since the huge energy released and the shallow coverage of the epicenter, buildings and public transport infrastructures in the region have suffered the tremendous damages accompanying with a large number of secondary geological disasters. According to the Sichuan Seismological Bureau data, the surface rupture lengths along the Beichuan~Yingxiu fault and the Guanxian~Jiangyou fault extend about 240km and 72km, respectively (Hong, 2009).

Based on the regional geological data (Huang, 2009), the Wenchuan earthquake epicenter was located in the geological tectonic transition zone between the Tibetan Plateau and the Sichuan Basin where the Longmen-Shan fault has been developing over the past hundreds of thousands of years. As can be seen in Fig.1, the crustal material moves slowly from the high Tibetan Plateau towards the rigid crust of the Sichuan Basin, in other words, the northward convergence of the India plate against the Eurasia plate renders the uplift of Tibetan Plateau. During the movement of the northeast striking reverse fault (thrust fault) on the northwestern margin of the Sichuan Basin, the geological tectonic stresses got concentration in the form of energy accumulation in Longmen-Shan fault zone. Therefore, the big earthquake occurred as the energy released here. The fault belts in the region are characterized by the complex tectonic geology, faults, geological folds, severe weathering rock, well developed rock joints and cracks, which had changed the physical and mechanics properties of rock mass intrinsically.