

公路与市政工程下穿运营高铁:一项具有国际引领地位的复杂技术

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近日,无锡地铁4号线盾构隧道又从运行速度为300 km/h的沪宁城际铁路下面成功穿越。

我国高铁在短短的十多年里,不仅实现了从无到有,而且建成了25 000 km的骨干网线路,而且其旅行速度及舒适性均居世界前沿,实现了量和质的双重快速发展。同时,随着我国城镇化战略的推进,各地基础设施建设也在加快,以城市轨道交通、市政管廊等为代表的城市地下工程,每年的建设量超过2 000 km,于是出现了大量的地下工程需要从运营高铁下方穿越的情况。为了保障高铁网络的正常运行,这些下穿工程必须严格控制施工变形,否则后果不堪设想。国际上在下穿普速铁路施工时,已经有过车毁人亡、并使铁路长时间中断运行的惨痛教训。

地下工程因下穿运营铁路施工而发生事故的原因非常复杂,但极其关键的因素是列车运行动荷载作用下开挖施工面的变形控制。由于铁路设施本来就是非常复杂的系统,而其列车动荷载与下穿施工时的开挖变形之间又存在相互耦合影响,致使这一系统变得更为复杂;另外,我国幅员辽阔,高铁途经地域的地质单元千差万别,这又增大了各下穿工程的施工设计难度。尤其在经济发达的长三角和东南沿海软土地区,一方面,大量基础设施在建,地下工程下穿高铁的量;另一方面由于土层软弱,致使变形控制极难。因此要破解地下工程下穿高铁这一难题,需要新的设计理论、控制技术和施工机械。然而,在我国,地下工程下穿高铁已经做到了“有规”可循。以同济大学(周顺华团队)为主的研究团队通过大量下穿铁路工程实践和多年科研攻关,研发了系统的、可靠的成套下穿高铁技术,形成了系统动力学的设计理论和毫米级的微变形施工控制技术,以及保证微变形实现的高精度施工机械,使我国在这一领域处于国际引领地位。从2012年杭州地铁下穿沪杭高铁至今,我国已经完成了大大小小数百项下穿高铁工程。正是基于这些复杂而又重要的工程,周顺华教授主持制定了国际上首部地下工程下穿高铁的技术标准——TB 10182—2017《公路与市政工程下穿高速铁路技术规程》,由此规范了地下工程下穿高铁的设计、施工、安全监测等各项技术要求。

Commentary

Highway and Municipal Engineering Cross under In-service High-speed Railway: A World-leading Complex Technology

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Recently, a new shield tunnel of Wuxi Metro Line 4 has successfully crossed under the Shanghai-Nanjing intercity railway line with the service speed of 300km/h. There already has technical specification to follow for metro line crossing under high-speed railway (HSR) in China.

HSR in China has made great achievements within only two decades: the backbone network lines have increased from 0 km to 25,000 km; the double rapid development of travel speed and riding comfort level is now in the forefront of the world. Meanwhile, following the promotion of urbanization strategy, the infrastructure construction in China is accelerating. In which, the annual construction volume of urban underground engineering represented by urban rail transit and municipal pipelines has exceeded 2000 km, resulting in large amount of underground construction that need to cross under the in-service HSR lines. In order to guarantee the regular operation and avoid serious consequences in HSR network, deformation in underground crossing construction must be controlled strictly. Many painful lessons in the world, like casualties from train derailment and long-term operation interruption during the underground crossing construction must be learned.

The causes of accidents during the underground crossing construction are complicated, the most crucial countermeasure is to control the excavation surface deformation under dynamic load induced by moving trains. Since the railway system is very

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作,西安地铁按照重奖励、轻考核的原则进行电能定额考评标准的制定,以推动电能定额管理工作的良好持续发展。

3.1.1 定额考核标准

定额考核分为1—4月、5—9月、10—12月等3个考核周期。责任主体部分严格控制考核周期内管辖车站或场段各区域的动力及照明用电量,不得超出定额指标。考核周期内定额管理区域实际用电量超出定额标准共分为3个等级(10%以内、10%~20%、20%以上),每个超标等级对应不同的考核分数;同时针对各责任主体部门在履行节能监督检查过程中发现其它部门、专业存在的节能问题,结合问题严重程度按单件问题进行考核。

3.1.2 定额奖励标准

考核周期内,车站或场段各区域实际动力及照明用电量低于定额标准共分为3个等级(5%以内、5%~15%、15%以上),每个达标等级对应不同的奖励分数。

3.2 电能定额管理的效果

通过开展电能定额管理工作,西安地铁车站动力及照明用电量由2014年的5 524 kWh/(站·d)降至2016年的5 328 kWh/(站·d),下降幅度达到3.5%,车站年平均节约电费约120万元;2016年第4季度场段动力及照明用电量为892万kWh,较2015年季度下降32万kWh,节约电费约27万元。

车站及场段动力及照明用电量整体控制情况较好,定额管理取得了良好的效果。

电能定额管理工作进一步加强了内部能耗管理控制,增强了广大员工整体节能意识,促进了各部门建立长效节能管理机制,全面贯彻落实用能、节能管理的相关要求,逐步改变了前期能源管理工作的被动局面。

4 结语

西安地铁总结了近年来的电能定额管理工作实践经验,取得了一定的节能效果,同时也发现了目前节能工作中存在的不足及下一步节能发掘潜力,为后续节能工作的良好发展指明了方向。

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complex, the mutual coupling effect exists between the excavation deformation and the dynamic load induced by moving trains, all of this makes the regular railway system even more complex. Due to the vast territory and various geological conditions in China, difficulties in the design of underground crossing engineering in different regions are further increased. The soft soil areas in Yangtze River Delta and the Southeast Coast are taken as an example, where the economy is very developed. On one hand, a large amount of infrastructure is under construction, requiring a lot of crossing engineering under HSR lines; on the other hand, the deformation control is extremely difficult because of the soft soil stratum.

In order to solve the problems in underground crossing construction, new design theory, control technology and construction machinery are urgently needed. With a lot of crossing-railway construction practices and decades of scientific research, the research team led by Prof. Zhou Shunhua (Tongji University) has developed a set of systematic and reliable technologies for underground crossing-HSR construction, including the design theory based on system dynamics, the construction technology for millimeter-scale deformation control, and the high-accuracy construction machinery to guarantee millimeter-scale deformation control, all of this makes China a world leader in the field of underground crossing-railway engineering.

In 2012, a Hangzhou metro tunnel successfully crossed under the Shanghai-Hangzhou HSR line, since then, hundreds of underground crossing-HSR projects have been completed in China. Based on these complex and important projects, Prof. Zhou Shunhua presided over the first technology code for crossing-HSR engineering in the world: Technical Specification for Highway and Municipal Engineering Crossing under High Speed Railway (TB 10182—2017), which standardizes the technology requirements for design, construction and safety monitoring of underground crossing-HSR engineering. The systematic solution for technical problems involved in underground crossing-HSR engineering, including but not limited to metro tunnels, road and pipelines, guarantees not only the HSR network operation, but also the smooth completion of the underground infrastructure related to railway lines.