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2011年日本东北地区太平洋近海地震对亚洲板块及韩国大地控制网的影响分析

黄軫详¹, 尹弘植¹, 黄鹤^{2,3}, 郑泰俊¹, 李東河¹, 魏桃栽^{1*}

1. 成均馆大学 社会环境系统工程学科, 韩国水原 440-746;
2. 北京建筑工程学院 测绘与城市空间信息学院, 北京 100044;
3. 现代城市测绘国家测绘地理信息局重点实验室, 北京 100044

The 2011 Tohoku-Oki earthquake's influence on the Asian plates and Korean geodetic network

HWANG Jin-Sang¹, YUN Hong-Sik¹, HUANG He^{2,3}, JUNG Tae-Jun¹, LEE Dong-Ha¹, WE Kwang-Jae^{1*}

1. Department of Civil & Environmental Engineering, Sungkyunkwan University, Suwon 440-746, Republic of Korea;
2. School of Surveying and Mapping Engineering, Beijing University of Civil Engineering and Architecture, Beijing 100044, China;
3. Key Laboratory for Urban Geomatics of National Administration of Surveying, Mapping and Geoinformation, Beijing 100044, China

摘要

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摘要 本研究分析了2011年3月11日发生的 $M_w 9.0$ 日本东北地区太平洋近海地震对亚洲地区和韩国国内GPS卫星常年跟踪站的位移影响. 为此, 利用了日本东北地区太平洋近海地震发生前后两周(2011年3月4日到3月18日)的GPS站点数据, 包括震中附近地区(韩国, 中国, 中国台湾地区, 日本和俄罗斯)55个GPS卫星常年跟踪站和284个IGS全球跟踪站, 并采用GAMIT/GLOBK软件进行处理和平差, 估算出所有GPS站点的同震形变. 结果显示, 日本东北地区太平洋近海地震引起的同震形变影响在亚洲地区比较明显, 包括日本和附近国家, 距离震中2702 km的中国武汉(WUHN)站也观测到同震形变. 为精确分析日本东北地区太平洋近海地震对韩国国家大地控制网的影响, 通过GAMIT/GLOBK软件计算出韩国GPS卫星常年跟踪站之间的基线长度变形, 并分析出弹性变形量. 结果表明: 大部分GPS站点均向震中方向膨胀, 且向震中的垂直方向收缩. 由日本东北地区太平洋近海地震导致的最大剪应变达到韩国国家大地控制网年均变形率的约7倍, 对韩国的地壳产生14.5~57.7 mm的水平位移, 并导致韩国国家大地控制网产生弹性变形. 因此, 在不及时更新维护韩国国家大地控制网的情况下, GPS测量成果将会发生最大20 mm的位置误差.

关键词 日本东北地区太平洋近海地震, 同震形变, 弹性变形, 大地控制网

Abstract: In this study, we analyzed the effects of seismic displacements due to the megathrust earthquake occurred near Tohoku-Oki area on 11 Mar. 2011 with $M_w 9.0$ magnitude in the context of evaluation of position change by the earthquake on the Asian and Korean GPS permanent stations. For this, two weeks GPS data observed around the event of Tohoku-Oki earthquake (4 Mar—18 Mar. 2011) were obtained from 55 GPS permanent stations in the vicinity of epicenter (Korea, Japan, Russia, China and Taiwan) and 284 IGS global stations. All available GPS data were processed and adjusted by GAMIT/GLOBK software to estimate the co-seismic horizontal displacements at each station. As the results of GPS analysis, the co-seismic displacements by Tohoku-Oki earthquake were clearly revealed in the GPS stations of Asian region, Japan and its neighboring countries, and even the change of horizontal position of GPS station (WUHN in China) which was about 2702 km away from the epicenter. Also, we performed the elastic deformation analysis using the deformation lengths of baselines between Korean GPS stations estimated from GAMIT/GLOBK analysis, in order to analyze the effects of Tohoku-Oki earthquake more precisely on the Korea geodetic network. Most GPS baselines of Korean geodetic network expanded in the direction of epicenter, whereas those perpendiculars to the direction of epicenter contracted. The size of maximum shear strain rate calculated during the event of Tohoku-Oki earthquake is 7 times greater than annual result of the Korean geodetic network. In conclusion, it was found that the Tohoku-Oki earthquake had resulted in the horizontal displacements, ranging from 57.7 mm to 14.5 mm in Korea. So, these irregular displacements caused the elastic deformations in Korean geodetic network and may cause a maximum error of 20 mm in GPS geodetic positioning results without updating the Korean geodetic network.

Keywords Tohoku-Oki earthquake, Co-seismic deformation, Elastic deformation, Geodetic network

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