

Accurate Determination of the Orthometric Height - A Case Study in Hong Kong

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Abstract: Orthometric heights of levelling benchmarks are practically determined from levelling and gravity measurements by applying orthometric corrections to levelled height differences. Currently, Helmert's definition of orthometric heights is mostly used, with the mean gravity computed only approximately from observed surface gravity by applying the Poincaré-Prey gravity gradient reduction. We present the state-of-the-art method for the orthometric height determination and demonstrate its practical applicability. The method utilizes advanced numerical procedures to account for the topographic relief and mass density variations, while adopting the Earth's spherical approximation. The non-topographic contribution of masses inside the geoid is evaluated by solving geodetic boundary-value problems. The method was applied for the first time to practically determine the orthometric heights of levelling benchmarks from levelling and gravity measurements and digital terrain and rock density models. The results obtained after the readjustment of newly determined orthometric heights at the levelling network covering Hong Kong territories are compared with Helmert's orthometric heights. This comparison revealed that errors in Helmert's orthometric heights vary between -3.13 and 0.95 cm. Such errors are very significant when compared to accurate values of the cumulative orthometric correction between -1.88 and 0.84 cm. Moreover, large errors (up to 1 cm) already occur at levelling benchmarks at very low elevations (<100 m). These findings demonstrate that the accurate determination of orthometric heights is crucial, even for regions with moderately elevated topography.

Keywords: gravity; levelling; vertical geodetic control; gravity gradient; orthometric correction