New approach to calculation of the building effect correction in microgravity technique

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A b s t r a c t : Microgravity surveys for cavity detection conducted in the interior of churches require high accuracy during data acquisition, and precise and fast data processing procedures. The old approach, which was used for computation of the building effect correction, consists of these steps: (i) various components of building were modelled as finite length vertical prisms with polygonal cross-section, to each component elevations for the top and base, thicknesses for walls and an estimated mean density (e.g. 1.70 g/cm^3 for bricks) were assigned; (ii) the gravitational effect of homogeneous prismatic bodies was calculated using equation derived by Cady (1980) in Potent software (Geophysical Software Solutions).

In vertical prisms approximation, it was not possible to include some specific architectonic features into the model, for example high lancet windows, broken arches or wall niches of various shapes. Moreover, creating of more detailed model of the church using the old approach was very laborious and time-consuming. Therefore, we have developed a new effective procedure for the calculation of building effect correction in microgravity technique. The new approach comprises of following steps: (i) the model of a building is created from photographs in Eos System's PhotoModeler Scanner software which is based on close range photogrammetry principles. Output is a three-dimensional polygonal body of the historical building in chosen coordinate system; (ii) the gravitational effect of homogeneous polyhedron is then computed using our program which is based on equation derived by Götze and Lahmeyer (1988).

We tested our algorithm on a simple model of building's walls composed of

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two polygonal prisms. Comparison of equations for calculation of the gravitational effect of the test model (Cady, 1980; Götze and Lahmeyer, 1988; Pohánka, 1988) has shown comparable results in microgal order.

The advantages of new method for calculation of the building effect correction are demonstrated on a real case study. Church of Virgin St. Mary's Birth located in Horné Krškany (western Slovakia), where two crypts were successfully detected using microgravity and GPR techniques in summer 2009 (Pánisová et al., 2010), was photogrammetrically documented for spatial building reconstruction purpose. The combination of geodetic measurements and the convergent photogrammetric method provided sufficient accuracy (few centimetres) and quality of obtained geometric information (location, size and shape) about object.

Our new method provides high accuracy of calculated building effect corrections, thus improving the ability of microgravity technique to detect more difficult identifiable cavities which are situated in a close vicinity to man-made structures. Such an improvement can contribute to a more precise construction of Bouguer anomaly maps and their interpretation. Moreover, the reconstruction of spatial models of historical buildings using close range photogrammetry represents a valuable contribution to the documentation of cultural heritage sites.

Key words: microgravity technique, data processing, building effect, cavity detection, close range photogrammetry, cultural heritage, archaeology

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