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APPLYING TRIGONOMETRIC LEVELLING FOR MONITORING THE VERTICAL DEFORMATIONS OF ENGINEERING STRUCTURES

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Abstract

Among the usual geodetic methods of vertical deformations measuring of structures and natural objects, geometrical levelling is one of the most accurate, but also requires compliance to specific conditions of slope and terrain accessibility. Where geometrical levelling is difficult or impossible to apply, the trigonometric levelling can be a viable practical solution, if there are followed a series of procedures to improve the accuracy of the final results.

For the case of classical geodetic measurements, where the network geometry has an important role, a high accuracy solution for the height differences has to ensure the mean square errors as small as possible in the vertical direction of the chosen coordinate system. In this situation, the whole monitoring network will be aligned in one vertical plane, so determining checkpoints height will result by a forward intersection in vertical plane.

The functional model of the adjustment method will include only zenith angles measurements, but horizontal distances are used to determine the coordinates of landmarks in a rectangular vertical system. Thus, by the imposed geometry of the network, the new points' coordinates will have a weaker component determined on the alignment direction of the benchmarks and a precise component determined on the height direction. In terms of graphical expression, after network adjustment by least squares method, the error ellipses will result in a very elongated geometric conformation, which are flattened in the interested direction of the height.

The case study consisted in applying method to an area of a pedestrian bridge, in which was simulated the vertical deformations by means of control points of adjustable height. Two cycles were performed for monitoring vertical deformations compared with the results of the geometric levelling measurements. The results showed that for short distances, the differences obtained for control points' height between the two methods were in the range [2.1 ÷ 5.7 mm] in both cycles of measurements. Height differences calculated between the two successive cycles of all the control points between the two methods were within the range of accuracy [0.8 ÷ 1.9 mm]. For long distances, this procedure of trigonometric levelling could provide improved results for height differences, in order to reduce the influence of zenith angles errors due to vertical atmospheric refraction.

Key words: error ellipse, forward intersection, height difference, trigonometric levelling, vertical deformation

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