Vertical Displacement Analysis Based on Application of Univariate Model for Several Chosen Estimation Methods

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Key words: Deformation measurement; Engineering survey; deformation measurement; engineering survey; estimation theory; robust estimation

SUMMARY

Considering a levelling network, which is established for vertical displacement analysis, we usually analyse several object points and a few reference points. The natural approach in such a case is to apply the multivariate functional models where parameter vector consists of the heights of the network points. However, some estimation methods, for example some variants of R-estimation, require another approach which is generally based on the univariate model. In such a case every object point is analysed separately from the others. The approach based on the univariate functional model can also be applied to the other estimation methods. Here, the following methods are considered: the least squares method (LSE), the Huber method (HE, the example of robust M-estimation), the Hodges-Lehmann weighted estimation (HLWE, the example of R-estimation) and two variants of Msplit estimation, namely the squared Msplit estimation (SMSE) and the absolute Msplit estimation (AMSE). The analysis is based on an example levelling network and Crude Monte Carlo simulations (MC). For LSE and HE both types of the functional model are applied. For the rest of the methods only the univariate model is used. Since some methods are regarded as robust against outliers one can consider variant without outliers as well as several variants with outlying observations. The paper focuses on the accuracy of the estimations in question and how such an accuracy can be affected by different outliers. To investigate better how outlying observations might influence the estimates, empirical influence functions (EIF) are also determined. Generally, the analysis based on the univariate model is more sensitive to the location of outlier; the estimation results depend also on the point location, namely the network structure. As for the estimation accuracy, the multivariate model seems a better choice; however, the results of the univariate approach are at least comparable in some variants analysed. The conclusions resulting from the analysis of EIFs obtained are more varied. In many variants the univariate approach yields better results, namely results that are less sensitive to the growing outlier. It is also interesting the AMS estimation usually predominates over SMS estimation, and in many cases it

seems to be the best solution overall. Summing up, the univariate approach to vertical displacement analysis can be an alternative or a supplementation to the more traditional approach based on multivariate functional models.