Optimisation of GNSS Deformation Monitoring Networks by Considering Baseline Correlations

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SUMMARY

In the study of deformations of man-made constructions or in geodynamics one usually needs to carefully monitor fixed objects attached to the deformable body. The purpose is to use precise observations to build up an accurate, reliable and possibly low-cost network around the objects to study their motion in short- or long-time intervals and to estimate the possible displacements or deformations among those objects. Frequently, such studies are performed to prevent unwanted disasters (e.g. due to earthquakes and landslides as well as the progressive or abrupt destruction of large-scale structures). Surveying engineering provides discrete information of the displacements of the network points, while the deformation could be a continuous phenomenon in space and time. Therefore, an approach should be developed to interpolate the collected information to enable us to learn more about the object deformations. Here, a finite element strain analysis is developed to determine the strain patterns from GNSS observations. Therefore, the precision of strain parameters in each element can be considered as a quality criterion for the optimisation procedure.

By considering GNSS observations one can perform the optimisation according to the pre-defined criteria and come up with the best location of receivers and optimum number of baselines. In practice, it is quite common to neglect the effect of correlations between baselines, and instead, use the single-baseline adjusted data in the optimisation procedure. However, in each session of observation usually more than two receivers are simultaneously taking data from a number of common GNSS satellites, which procedure inevitably leads to between-baseline correlations. Our study designs an optimal observation plan for a GNSS monitoring network with the aim of determining possible displacements and deformations. Firstly, the developed methodology will be tested on a simulated network. Thereafter, it will be applied to optimise the current observation plan of the GPS monitoring network of Lilla Edet in the southwest of Sweden.