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GNSS Monitoring of Deformation within heavy civil infrastructure

Jean-Philippe Montillet (1), Timothy Melbourne (1), Walter Szeliga (1), and Gavin Schrock (2)

(1) Cascadia Hazards Institute, Central Washington University, WA, United States of America (montilletj@cwu.edu), (2) Washington department of public utilities, WA, United States of America (gavin.schrock@seattle.gov)

The steady increase in precision simultaneous with the decreasing of continuous GPS monitoring has enabled the deployment of receivers for a host of new activities. Here we discuss the precision obtained from several multi-station installations operated over a five-year period on several heavy civil-engineered structures, including two earthen-fill dams and subsiding highway overpass damaged by seismic shaking.

In the past 5 years, the Cascadia Hazards Institute (Pacific Northwest Geodetic Array) at Central Washington University together with the Washington department of public utilities (Land Survey) have been monitoring several structures around Seattle area including two dams (Howard Hansen and Tolt). One aim of this study is to test the use of continuous GNSS in order to detect any deformations due to rapid pool level rises or to monitor the safety of a structure when an Earthquake strikes it. In this study, data is processed using Real Time Kinematic GPS with short baseline (d < 500 m) and GPS daily position (PPP).

However, multipath is the most limiting factor on accuracy for very precise positioning applications with GPS. It is very often present indoors and outdoors, especially in narrow valleys with a limited view of the sky. As a result, multipath can amount to an error of a few centimetres. Unfortunately, the accuracy requirements of precision deformation monitoring are generally at the sub centimetre level, which is presently a big challenge on an epoch-by-epoch basis with regular, carrier phase techniques. Thus, it needs to be properly mitigated. In this study, several stations are set up on the dams (4 stations on the Tolt reservoir and 10 stations on the Howard Hansen dam), and spatial filtering can then be used to mitigate multipath. In addition, several signal processing techniques are also investigated (i.e. Empirical mode decomposition, sidereal filtering, adaptive filtering).

RTK GPS should allow to monitor rapid deformations, whereas GPS daily position is used to detect long-term deformations such as the pool level rises due to the melting of ice cap on surrounding mountains. Note that RTK measurements are processed with the MIT software TRACK and the GPS daily positions estimated with GAMIT-GLOBK.