Impact of GNSS Antenna Calibration on High-Precision Bridge Deformation Monitoring

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SUMMARY

n a recent research project, high-precision GNSS measurements were carried out to monitor the structural behaviour of a test bridge that was deliberately destabilized under controlled conditions. The objective was to detect bridge deformations with millimetre-level accuracy in real time and to assess the influence of antenna calibration on the achievable measurement precision.

For this purpose, five GNSS antennas were individually calibrated and installed on the bridge within a dedicated test setup. The calibration procedure included phase centre variation corrections, offset determination, and the characterization of antenna patterns with respect to multipath effects and elevation-dependent errors. The results were then compared with those obtained from uncalibrated reference antennas to quantify the direct impact of calibration on the positioning accuracy.

The findings demonstrate that careful antenna calibration significantly enhances GNSS measurement performance. By eliminating systematic antenna-related errors, position deviations were reduced to the millimetre range even under dynamic bridge loading and induced destabilization. This represents a level of precision that was previously considered unattainable with standard GNSS techniques.

The presentation outlines the calibration methodology, experimental setup, and data analysis workflow. Particular attention is given to the comparison between calibrated and uncalibrated antennas in terms of signal quality, repeatability, and model stability. The results highlight the crucial role of precise antenna calibration for Structural Health Monitoring (SHM) applications using

GNSS.

In conclusion, the study shows that combining advanced GNSS technology with rigorous antenna calibration enables unprecedented precision in deformation monitoring. This approach opens new perspectives for future bridge monitoring projects and contributes to the ongoing evolution of high-accuracy GNSS-based measurement techniques in engineering geodesy.