Accuracy Assessment of GNSS Observation Rods under Different Tilt Angles and Receiver Models in Sri Lankan Survey Conditions

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SUMMARY

Accurate and reliable positioning is essential for modern surveying and geospatial operations. With the growing integration of Global Navigation Satellite System (GNSS) technology in Sri Lanka, understanding the effect of GNSS rod tilt on positional accuracy has become increasingly important. This study evaluates the horizontal positional accuracy of GNSS observations under varying tilt angles and compares performance across commonly used receiver brands and models, referencing Total Station data as the control benchmark.

Field observations were conducted at 88 reference points within the premises of the Surveyor General's Office, Colombo. Total Station observations were used as the baseline reference. GNSS measurements were obtained using Hi-Target, South, CHC, eSurvey (E600, E100), and TOKnav (T10 Pro, T5 Lite) receivers, each tested at four tilt angles (0°, 15°, 30°, and 45°). All instruments were connected to the Survey Department's CORSNET via GSM for real-time kinematic (RTK) corrections. The study analyzed Root Mean Square Error (RMSE), mean error, and standard deviation to quantify horizontal deviations from reference coordinates.

Results indicated a direct correlation between antenna tilt and horizontal error. At 0° tilt, all instruments achieved sub-2 cm accuracy. At 15° and 30°, positional errors increased moderately, while at 45°, receivers without tilt compensation showed errors exceeding 10 cm, whereas tilt-compensated models maintained accuracy within 5 cm. The overall RMSE across all valid measurements was 0.155 m, confirming that tilt significantly affects GNSS-derived coordinates.

This research presents the first systematic local evaluation of tilt effects on GNSS accuracy within Sri Lanka's surveying context. The findings underline the importance of tilt-compensation technology, standardized observation procedures, and field training to enhance positional reliability.

The outcomes will inform future GNSS equipment selection and national accuracy standards for the Survey Department of Sri Lanka.