Modeling the Uncertainty of Directions Measurement by Using Total Stations

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SUMMARY

The particular demand of modern infrastructure's construction and the high level of accuracy, which is provided today by the high end total stations (TS), lead to the imperative need to ensure their proper operation. Namely, a TS must be checked for systematic or random errors that contribute to every measurement. As reported, by experimental data, the distance measurement is not influenced by flawed targeting. Thus the observer's contribution is negligible. The distance measurement is more accurately than the directions for current surveys (100m-400m) due to the advanced electronic systems for distance measurements and the minimal interference of the observer. On the other hand the directions measurements are influenced by parameters like the nominal accuracy of the total station, the observer, the target and the environmental conditions. More analytically the personal perception of the observer for the right targeting, the type of target, the quality of the telescope's lenses, the quality of the reading sensors of the TS and the distance between the total station and the target make the direction measurements more sensitive. This paper proposes a reliable procedure for the determination of the uncertainty in the directions readings of TSs. According to the proposed procedure, readings of directions are taken by using a TS under check at a series of 20 targets which were established at an indoor laboratory hall. The number of the targets is defined by a simulation of the checking field, by using the "Monte Carlo" method. These readings are compared; with their "true" values which had been acquired by a first class TS. Both, the systematic and random errors of the TS under check, were calculated by using the appropriate adjustment which fit to the measurements by using the least squares method. Moreover, in the outcome of the equation the "scale" of the TS was calculated as a factor. The "scale" presents the grade of the TS's identification with the prototype or even its regularity. However, the determination of TS's uncertainty is utterly useful. In this way, not only the measurements which are carried out, by using this TS, could be corrected but also the total error can be estimated. Likewise, the certification of TS for use is confirmed for every specific application. The proposed methodology can be also used for checking the nominal accuracy of TSs. The application of the methodology shows that, it is advantageous and time-efficient and the reliability of the results is ensured. Only half an hour is required for a TS's check. Finally, useful remarks are come out by the comparison of the proposed method with the standards ISO 17123-3 and 17123-5.